THE

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ELECTRICAL REVIEW.

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ELECTRICITY IN TEXTILE MILLS.

WE reproduce elsewhere in this issue an account of the proceedings at the Congress of the Textile Institute last week, so far as they relate to the use of electricity for motive power, and to the choice of a prime mover. The discussion arose out of the dissolution of the special joint committee which was appointed last year to investigate the respective merits of mechanical and electric driving; the composition of the Committee was apparently regarded as unsatisfactory, though we do not see any reason why its conclusions would not have been impartial and reliable, and the Textile Institute undertook the investigation on its own account. Thus the organised discussion at the Congress was the first step towards an authoritative settlement of the controversy which has arisen on this topic, and we trust that the inquiry will be energetically pursued to a final verdict, which will be all the more weighty when delivered by such a tribunal. It was unfortunate that, owing to the length of the four papers, the verbal discussion was curtailed, but further opportunities will no doubt be found for a more adequate debate.

In the meantime, we have a strong impression that the question is rapidly solving itself, as such matters have a way of doing when there is a pecuniary advantage to be gained by prompt action. While the rival experts are contending in the arena, the practical hard-headed mill-owners are getting on with the work. They are much too 'cute to dally with so important a question, and they appraise the balance of advantage not in terms of pounds of coal or watts expended, but in £ s. d. Hence it is that, as Mr. Crowley stated, within 18 months the number of looms driven by individual motors has risen from under 300 to more than 7,000, and the employment of electric power in textile mills generally has made great strides, so that the manufacture of the apparatus and the supply of energy for this purpose have already become important branches of the electrical industry. That they are destined to attain to vastly increased proportions may be regarded as certain.

It is noteworthy that the advocates of steam and gas engines as prime movers not only accept electrical transmission as entirely agreeable to them, but even, more or less directly, urge its adoption, and the speaker for the Diesel engine was at least neutral. But these interests, of course, would not be greatly affected by the use of electricity, for their plant must be employed either in the private engine room or in the central power station. The makers of mechanical transmission appliances, who have yet to be heard, will adopt a less friendly attitude.

The efforts of the engineers and manufacturers who have so energetically carried on the campaign during recent years, and who, we hope and believe, are now about to reap the reward of their exertions, are deserving of the highest praise. It is interesting to observe that their opponents have been on the defensive all the time, fighting a losing battle.

The facts brought out by Mr. Crowley regarding the material advantages derived in practice from the adoption of the electric drive are extremely interesting, and highly gratifying, the increase of output being greater than has usually been supposed. It will be observed that the greatest benefit is realised when the fullest advantage is taken of the system—that is, by adopting the individual motor drive, which exhibits quite as great a superiority over the group drive as the latter does over mechanical transmission.

The results remind us of the history of the steam engine, as affected by the development of electricity supply. There is no doubt that a very large proportion of the great improvement which took place in the efficiency and economy of steam plant towards the end of the last century was directly due to its application to the generation of electrical energy, and to the facilities afforded by electricity for exact measurement; in a similar way, the electric motor has drawn attention to the deficiencies of even the most approved and highly developed systems of mechanical transmission employed in textile mills, and has led to the minute examination of their behaviour, revealing unsuspected possibilities of improvement.

The British Association.

THE papers which we reproduce in abstract to-day will be found of exceptional interest, as they relate to two new developments which, though at present in embryo, will in all probability be ultimately of immense importance to the electrical industry. In his paper on the Gas Turbine, Dr. Dugald Clerk concisely sums up the present condition of that much-discussed machine, which affords some of the most interesting, and, at the same time, most difficult, problems for the mechanical engineer and his *confrères*—the metallurgist and the chemist—to tackle. Were a satisfactory solution attained, its effect on the social and industrial applications of electricity would undoubtedly be profound and far-reaching. We fear, however, that a vast amount of work remains to be accomplished before that desirable end is attained.

Mr. Mavor's paper on "Electricity in Marine Propulsion" similarly marks an epoch in the evolution of a new system. With admirable perseverance and tireless industry he has kept on pegging away at the problem of the adaptation of electricity as the link between the high-speed engine and the slowly rotating propeller, and has had the satisfaction at last of embodying his views in the equipment of a new vessel of considerable tonnage. We congratulate him on his present and prospective success, and look forward to the wide adoption of electricity on ships of all classes.

The extraordinary flexibility of electrical systems, which seem capable of fulfilling almost innumerable functions, is well exemplified by the several instances cited by the author.

Train Dispatching by Telegraph.

A MONUMENT has been erected at Harriman, New York, U.S.A., to commemorate the sending of the first "train order" by telegraph, which led to the universal adoption of the system on American railways. To Charles Minot, general superintendent of the Erie Railroad, the credit is due for taking the first step, in 1851. The story is told in an admirable pamphlet mentioned in our "Book Notices" to-day. In those days the single-line railways were operated on a system, according to which trains going in opposite directions were timed to meet and pass one another at specified stations; if one was late, the other had to wait at the passing place until the late one arrived. Minot was travelling on such a line, when his train was held up at "Turner's" station in this way; it occurred to him to telegraph to the next station, 14 miles away, and inquire whether the other train had reached there, and finding that it had not done so, he telegraphed an order for it to be held there, while he proceeded to drive his train (the engine driver having refused to carry out so revolutionary a proposition) to that station. Fortunately, the result proved satisfactory, and the new system was launched upon the world. It may seem obvious to us nowadays—the most natural thing in the world; but the telegraph in those days occupied a very different and more humble position, and no doubt the feat was one well worthy of the memorial which has been erected on the site of the old Turner station.

Copper.

MESSRS. MERTON'S mid-monthly return (September 14th) shows a slight decline in price, and lower demand. Stocks (England and France and afloat from Chile and Australia) are 270 tons less on the fortnight, traceable mainly to the smaller quantity afloat from Australia than at the close of last month. As would be expected, English stocks have increased 338 tons, and French stocks are 442 tons heavier. Rotterdam shows a reduction of 70 tons, and Hamburg of 524 tons, probably due to brisk German trade.

In detailed supplies we find North America sending over a smaller quantity than half a month's average supply, while Spain and Portugal are represented by only 30 tons (average supply per month 1,700 tons). Shipments from Chile and Australia, on the other hand, exceed the average. Total deliveries, at 15,685 tons, are distinctly low. The market appears to be waiting for some expected improvement in outlook.

American stocks (the figures of the American Producers' Association) at the end of August were 1,597 tons less than at the end of September—not a heavy reduction. Last year, however, the figure was only 1,919 tons on a price of £56 per ton, and the stocks rose during September. The total visible supply, including Holland and Germany, stands (end of August) at 71,181 tons, a reduction of 1,839 tons on that for the end of July. For the same date last year it was 144,935 tons, or more than double. The total deliveries (European) for September, 1911, were 33,043 tons, the lowest for the year. The labour outlook at that period was, however, very gloomy.

Two Continental Exhibitions.

Two Exhibitions are to be held on the Continent during 1913, to which the attention of British manufacturers and traders should be directed. The Barcelona International Exhibition will be opened by the King of Spain on January 1st, and during its four months' run British exporters should have an excellent opportunity of gaining intimate knowledge of industrial and commercial possibilities in Spain and of establishing relations with desirable buyers. The period chosen for the Exhibition is unusual to us in this country, where most of our events of the kind run between May and October, but we understand that from January to April is essentially the season of the year when Barcelona, the commercial and industrial capital of Spain, is visited by many buyers representing the leading South American firms. Our Continental competitors for Spanish and South American trade are stated to be fully alive to the importance of the occasion, and it is to be hoped that British electrical and engineering firms will not adopt a weak policy, for our export trade to Spain has certainly required increased attention. The other Exhibition to which we are asked to allude is the International Belgian Exhibition which opens at Ghent in April next. Here the wisdom of manufacturers of particular classes showing combined or co-operative exhibits, avoiding overlapping and purposeless rivalry, is being urged. The special features of this Exhibition will be machinery, machine tools, textile trades and applied arts. The addresses in London from which particulars of these two exhibitions can be obtained are given in our "Business Notices."

THE QUARTZ MERCURY VAPOUR LAMP FOR ALTERNATING CURRENTS.*

In recent years the mercury vapour quartz lamp has advanced in favour considerably, partly because of its high efficiency, and partly because the colour of its light is almost white compared with that of the older mercury-vapour lamps. Both these improvements are the direct result of the higher

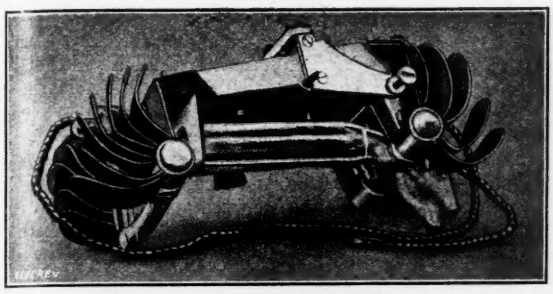


Fig. 1.

temperature permissible in quartz glass, this higher temperature being produced by increasing the voltage drop per cm. of tube from about 1 volt (as was usual in the old Cooper-Hewitt glass lamp) to about 12 volts.

Hitherto mercury-vapour lamps have been chiefly confined to direct-current circuits, because of the well-known difficulty of maintaining an arc in any metal vapour unless the negative electrode is permanently maintained above a certain minimum temperature. This difficulty can, however, be got over with alternating currents if the double anode arrangement used by Cooper-Hewitt in his mercury-vapour rectifiers is adopted.

An alternate-current quartz lamp arranged on this principle has been recently developed at the laboratory of Messrs. Heraeus, of Hanau, and is shown in fig. 1. The diagram of connections is shown in fig. 2. The quartz burner is provided with two separate anode chambers in a fork at one end and with a cathode chamber at the other end. The anodes

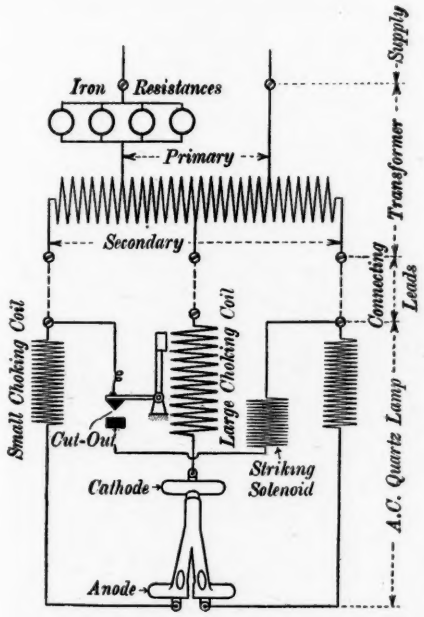


Fig. 2.

are connected to the two ends of the secondary of the supply transformer whilst the carthode is connected to the centre point of the secondary. When the lamp is alight, a more or less pulsating direct current flows between the cathode and the centre of the transformer winding, whilst the two anodes take it in turns to supply current to the lamp—each only being active for half a wave at a time, viz., so long as it happens to be the positive pole of the transformer. Owing to the absence of cathode excitation, there is little danger of current passing from one anode to the other, even though the voltage between them is twice the working voltage of the lamp.

The striking of the arc is effected by tipping the lamp until a narrow thread of mercury bridges across from cathode to anode for a moment. At the same time, the liability to short-circuit the two anodes is avoided by providing a narrow dividing wall, about ¼ in. high, along the bottom of the lamp from the anodes practically to the cathode. The electromagnetic tipping device is provided with a repeating arrangement so that, in case the arc does not strike because the mercury thread is either broken at an instant when the current is zero, or at an instant when the anode at which the break occurs happens to be negative, the tipping process shall be repeated once or twice until the lamp lights up. The tipping solenoid is eventually disconnected, when the lamp is alight, by means of a cut-out. A damping device

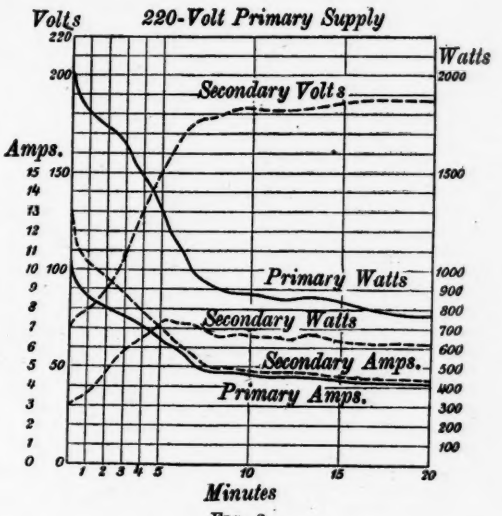


Fig. 3.

is added in the form of a simple clockwork mechanism which allows a quick forward motion, but a slow return, through the action of a small air vane.

For each lamp rating in watts only a single size of burner is made whatever the supply voltage—the necessary adjustment being made in the transformer instead of in the lamp. Thus the 770-watt lamp is arranged to take 180 volts across the burner. The transformers are then wound for 2 × 180 volts on the secondary and any desired primary voltage. For the ordinary 110 and 220-volt supplies auto-transformers are used, and tappings are provided to suit slight variations from these voltages.

A small series resistance in the form of thin iron wire enclosed in four glass bulbs is provided, in order to prevent an excessive rush of current when striking the arc.

Choking coils to steady the direct current through the lamp are also provided at the cathode, and at each anode as shown in fig. 2. The tipping solenoid and its cut-out are connected right across the whole secondary voltage. The transformer, starting resistance and choking coils are usually put in a separate case independent of the lamp.

When the arc is first struck a heavy current passes (about 10 primary amps. and 13 secondary amps. with a 220-volt supply), bringing the iron resistances up to a dull red glow, whilst about 150 volts are lost across them. The secondary transformer voltage falls to about 70 volts. These conditions gradually change as shown in fig. 3 until, after about 10 minutes, the steady state is reached, with only 12 to 15 volts lost in the resistance.

The efficiency of this alternating lamp is hardly lower than that of the direct-current lamp, one Hefner c.p. being

* Herr F. Girard, *E.T.Z.*, July 4th, 1912.

obtained for about ·25 watt. This is because the reduced starting resistance loss in the A.C. lamp approximately compensates for the additional losses involved by the use of the double anode.

As regards sensitiveness to voltage variations, the A.C. and D.C. lamps are about alike, both allowing variations of 10 or more volts without trouble. In consequence of the necessity for the transformer, large choking coils and more complicated burner, the cost of the A.C. lamp is, however, considerably greater than that of the D.C. lamp at present.

THE USE OF MICA IN THE INSULATION OF ELECTRICAL APPARATUS.

By A. P. M. FLEMING, M.I.E.E., and R. JOHNSON, A.M.I.E.E.

The valuable insulating properties of mica are generally well known. There appears to be, however, a lack of knowledge among engineers as to the limitations to the use of this material, and it is frequently called upon to fulfil quite impossible functions in specifications for the insulation of electrical machinery.

This article has been prepared with a view to correcting some of the erroneous impressions prevalent in connection with the practical use of mica, and at the same time to afford some general information for the guidance of those engineeers to whom the subject is of importance, but whose opportunities for carrying out personal investigations are very limited.

The subject will be dealt with in four parts :—(1) Raw mica ; (2) Mica products ; (3) Commutator mica ; (4) Other applications of mica.

1. *Raw Mica.*—Mica is found as a constituent of granite, gneiss and mica schist. The larger crystallisations occur in granite veins intersecting these rocks. There are a great number of micas. That most commonly used for electrical purposes is known to mineralogists as Muscovite. Chemically it is a double silicate of aluminium and potassium, with varying proportions of impurities. An analysis of one sample gave :—

Silica	46·3	Fluorine	0·7
Alumina	36·8	Water	1·8
Potash	9·2		
Iron sesquioxide ...	4·5		99·3

There are many valuable deposits of Muscovite in the United States and in Canada. In New England plates 2 to 3 ft. across have been obtained. Large quantities of mica are now obtained from India. A specially soft kind, commercially known as amber mica, is obtained from Canada. Much of this amber mica consists of the mineral phlogopite, and one analysis gave :—

Silica	43·00	Iron sesquioxide ...	1·71
Alumina	12·37	Fluorine	5·67
Potash	10·32	Water	0·38
Magnesia	27·76		
Soda	0·30		102·35

The colour is mainly a yellowish brown, with a copper-like reflection. This amber mica is quite distinct from the other qualities, not only on account of its colour, but its crystalline structure is different, and also such physical characteristics as cleavage, hardness, flexibility, insulating properties and resistance. It is of particular value on account of its softness, and this characteristic will be specially dealt with later in connection with mica for commutator work.

In general, the hardness of mica lies between two and three in the standard scale—that is to say, two to three times the hardness of talc, while the specific gravity ranges from about 2·7 to 3·1.

The qualities of mica most extensively used are the harder and cheaper varieties known commercially as white, ruby and soft green, mined mainly in India. A very hard form, also of a greenish tint, mined in the United States, is seldom used for electrical work.

In addition to these qualities, there are varieties of each, mottled or stained with flecks of green, ruby, brown and black colour.

As regards insulating properties, amber mica has about half the dielectric strength of the other varieties used. When tested in sheets of ·002 in. or ·003 in. thickness, the voltage required to puncture amber mica is about 2,000 volts per mil. With the white, ruby and soft green varieties, the voltage per mil to produce breakdown is about the same for each, and runs from 3,000 to 4,000 volts. Compared with other insulating materials, even the lowest of these values is so high that, as a general plan, it may be said that any kind of mica may be used for any insulating purpose to which its other characteristics render it adaptable.

The principal features to be considered in selecting mica for any particular insulating purpose are cleavage, flexibility, softness and cost. As regards the latter, amber mica is by far the most expensive. It is also more difficult to cleave into thin laminæ ; there is considerable waste in cleavage and a marked tendency for the laminæ to split, so as to form "heels"—*i.e.*, there is considerable difference in the thickness of opposite edges of the same sheet.

The harder varieties are cheaper, and cleave more readily ; in fact, in general the harder the mica the cheaper the cost of cleavage and the less the waste. These varieties can be split economically as thin as ·0005 in., or about half the thickness of the usual amber splittings.

As regards hardness, the micas can be classified as follows, starting with the softest :—Amber ; green (the variety known as soft Madras green) ; ruby, white, India ; green, U.S.A. In addition to this classification, various trade terms are sometimes introduced by suppliers to mark special consignments.

It should be noted that while the amber mica is consistently softer than the other varieties, the difference in hardness between it and the softest of the green micas is not great. Further, samples of white mica, quite as soft as Madras green, can sometimes be obtained and *vice-versâ*. But while experts are able to judge this by merely handling the material, the above classification is, in general, a fairly good guide to a purchaser.

Regarding the mottled mica noted above, this is frequently avoided by purchasers under the mistaken idea that the insulating properties must necessarily be poor. In the vast majority of cases, however, this is by no means the case, and very rarely is there found to be any appreciable difference in insulating value between the clear and mottled portions of the same sheet. The discolouration in some cases has been caused by the action of radio-active substances, in others it is due to the presence of microscopic quantities of organic material enclosed between laminæ, and in others, again, to slight traces of inorganic deposit.

Mica is obtained from the mines in rough flakes encrusted in schist, the latter being trimmed away with the fingers or by knife or machine on the spot. The sheets are graded into sizes varying from a few square inches to 100 sq. in. and upwards in area, and in thicknesses varying from about $\frac{1}{16}$ in. to $\frac{1}{4}$ in. They are further graded and shipped as "knife" or "thumb" trimmed, as the case may be, the former best lending itself to further cleavage.

The cost of raw mica of any variety varies enormously with size, *e.g.*, soft green mica of approximately 3 sq. in. of superficial area can be bought as cheaply as 5d. per lb., whereas pieces of 30 sq. in. will cost as much as 6s. per lb.

It will be readily seen that the most economical size of raw mica to purchase depends on the use to which it is to be put. When the laminæ are to be built into sheets, as is usually the case, it becomes a compromise between the cost of splitting and building and the initial cost of the raw mica. The cost of raw amber mica runs approximately from three to four times that of soft green.

For the bulk of work where the harder varieties of mica are used, two sizes have become practically universal, and are known as No. 5 and No. 6 respectively. These sizes are of irregular shape, and are of such an area that from No. 5 mica a circle having a diameter of about 2 in., and from No. 6 a circle of about $1\frac{1}{2}$ in., may be cut.

Large sizes are used for special purposes, as will be noted later. Amber mica is ordinarily sold in sizes varying from 6 to 10 sq. in.

Many users purchase their mica already split into laminæ of a thickness suitable for building into sheets, others prefer to split it themselves. Sometimes this is done by machine, but more usually by knife in the hands of girl workers.

It is not generally appreciated that mica is capable of absorbing considerable quantities of water, oil, &c.; in fact, nearly all raw mica contains considerable moisture absorbed between its laminæ. Similarly it will readily absorb oil by capillary action along the surfaces of the laminæ.

The effect of moisture between the laminæ is to apparently increase the flexibility—a characteristic that is liable to be mistaken for softness—the resilience is destroyed, and the mica assumes a talc-like nature. As regards softness, while a comparison of different qualities of mica can be obtained by testing with a hardened "scraper," an expert can form a good idea by the mere feel of the material.

Mica is unaffected by heat until a temperature of several hundred degrees centigrade is reached. The harder varieties then undergo a remarkable change. The laminæ separate, giving a very flexible and soft character to the mica, which tends to disintegrate into very small scales or flakes. Some attempts have been made to utilise this softening effect produced by "annealing" mica, as will be noted later. Amber mica is much less affected than the other varieties, possibly because it contains less water in its composition.

Mica is generally employed built up into large sheets from small splittings in the manner described later. Block mica and splittings without any adhesive cement have only a restricted application on account of the limited area of the sheets. For small insulating washers, and to some extent for commutator work, mica in its pure form is used, and this will be considered at greater length in dealing with commutator insulation.

2. *Mica Products.*—For most purposes where mica is employed as an insulator, it is first necessary to build it up into one of the following forms :—

Stiff flat plates of various thicknesses.

Flexible sheets.

Sheets made up of a combination of mica with paper or cloth.

In each of these forms the process of manufacture is similar, in that small mica splittings are cemented together in layers by means of a suitable insulating varnish.

The mica splittings vary from ·0005 in. to ·0025 in. in thickness, and are usually of the No. 5 or No. 6 size.

When specially uniform sheets are required, mica of rectangular shape is employed, otherwise quite irregular pieces are used on account of cheapness. The splittings are overlapped when irregular-shaped pieces are used. Each layer as it is built up is sprayed or brushed with varnish, and the layers are so arranged that the joints are broken.

For stiff flat plates the sheets are usually built up with a varnish made by dissolving shellac, or one of the many similar gums, in wood alcohol or methylated spirits. When a sufficient number of layers have been thus prepared, the sheets are heavily compressed in a steam-heated press to expel the solvent and excess varnish. When cold, they are usually milled to a uniform thickness. Except for commutator work, where amber mica is sometimes employed, the cheaper green or white mica is used for these sheets. The trade term "Micanite" is generally applied to mica built up in this form.

Flexible sheets are built up in a similar manner, except that a non-drying varnish is employed for cementing the laminæ together, and the hot pressing is omitted. Greater care has therefore to be exercised in the building, so as to obtain uniformity in the thickness of the sheet. For this work also, the splittings should be the thinnest possible.

Insulating sheets composed of mica and paper or cloth are prepared by cementing one or more layers on to the paper or cloth with either shellac or a flexible sticking varnish, according to the use to which the product is to be applied.

Great care must be exercised in the choice of flexible varnish to be used, as there are a number of preparations on the market that are chemically active and liable to attack any copper with which they may come into contact. For mica sheets backed in this manner with paper or cloth, the thinnest soft green splittings are best employed, so as to give the most flexible product. Scrap and powdered mica are used to some extent in the preparation of many of the fire-proof insulating compositions sold in the form of bushings, strain insulators, arc shields, &c.

3. *Commutator Mica.*—For the insulating of commutator segments from one another, mica is almost invariably used, and also, with few exceptions, for the insulating bushings between the segments and supporting frame.

Considering first the insulating of the segments, the mica sheets employed are usually from ·020 in. to ·035 in. thick. Unless the mica is milled out between the copper segments on the wearing face in the manner referred to later, it is necessary to use a quality of mica that will be as soft as, or softer than the copper itself, otherwise there will be uneven wearing of the commutator, ultimately resulting in high mica and destructive sparking under the brushes. The safest plan is, of course, to use amber mica, but this entails high cost, and the softer green micas are now very largely employed with, on the whole, satisfactory results. In the case of large machines, it becomes possible to make up the insulating sheets with the wearing surfaces only of amber mica, and the remainder of green or white mica, the increase in expense over sheets made up entirely with hard mica not then being very great.

Considerable difference of opinion exists as to the relative merits of "pure" mica and built up mica for the insulating of commutator segments. Many engineers maintain that in cases where oil has crept on to the commutator, pitting of the insulation between bars has rapidly resulted when the insulation has consisted of built-up mica, whereas pure mica has withstood such deterioration fairly well. It is the writers' experience, however, that in this respect there is very little to choose between built-up mica—when well made—and pure mica. Deterioration is bound to occur in either case when oil is present on the surface of the commutator, and the prevention of this class of trouble can only be effected by keeping oil off the commutator by means of properly designed bearings and oil throwers.

Another objection put forward to the use of built-up mica is that the small pieces composing it are liable to work loose and creep up from between the bars. While this may happen with poorly manufactured material, experience does not show it to be the case where the insulation has been properly prepared.

In the case of large machines the question resolves itself, as it then becomes impossible to obtain pure mica in sheets sufficiently large for the purpose, and there is no alternative to the use of built-up sheets.

As a commercial proposition where the segments are longer than about 12 in., a pure mica insulation is impossible. When the segments are small, say, not longer than about 4 in., economy favours the use of pure mica, the strips being sawn or punched out of the raw block. When this is done the increase in cost due to the large mica is more than compensated for by the saving in the building, pressing and milling.

The one great advantage that well built-up mica possesses over the pure sheet, is that it ensures uniformity of wear, the splittings being thoroughly well mixed.

With pure mica it is impossible to ensure that all the segments will be of equal softness, and even in the same sheet hard spots will often occur.

The principal feature in the manufacture of the hard sheets of built-up mica for commutator segments is the pressing. The pressure employed should be as great as possible, and the temperature sufficiently high to expel all traces of solvent. The amount of shellac or other insulating cement left in the finished segment should not exceed 10 per cent. by weight; 5 per cent. is sometimes attained.

Where pure mica segments are used, improved wearing is obtained by dividing the sheets, after these are cut to size, into as many thin laminæ as possible, and reassembling to the thicknesses required before placing into position between the copper bars.

"High mica" will occasionally occur in practice whatever kind and quality is used, and it is now common practice to mill down the mica about $\frac{1}{16}$ in. below the wearing surface of the copper of the finished commutator. This may appear to involve some risk of trouble due to the lodgment of dirt in the channels thus made. In actual practice, however, trouble of this kind is scarcely ever

experienced, and the only drawbacks to the practice are some slight tendency to cause "chattering" of the brushes and the necessity of re-milling the ducts from time to time.

For very high-speed commutators rectangular strips of considerable size have frequently to be employed in the building-up of the mica sheet, the strips being arranged so that their ends are held in place under the shrink rings or bands around the commutator. If this is not done the cement and the friction of the surfaces may not be sufficient to prevent the mica being forced out from between the bars.

(*To be concluded.*)

THE BRITISH ASSOCIATION.—III.

On Monday, September 9th, in Section B (Chemistry), the Committee on Electro-Analysis submitted an interim report, stating that the work was still in progress. In Section G, a discussion on the Gas Turbine was opened by Dr. Dugald Clerk, whose paper is reproduced in abstract below. An experimental investigation of the Transmission of Heat was described by Dr. C. N. Lander and Prof. Petavel, to which we shall refer later, the data relating to the insulating of steam pipes being of interest. Dr. J. G. Gray and Mr. G. Burnside treated of some new gyroscopic apparatus.

On Tuesday Mr. H. A. Mavor presented to Section G an interesting paper on "Marine Propulsion by Electrical Transmission," which he summarised with a degree of wit and humour that rendered the hearing exceptionally enjoyable. Below we abstract his paper at considerable length, together with the discussion.

The next paper was by Mr. Axel Welin "On Lifeboats on Ocean-going Ships." He provides electric motors for hoisting the boats inboard again after a drill (they weigh from three tons upwards, and have to be lifted in some cases 70 ft. above the water). They are lowered on the brake. The paper was effectively presented, and a very fine set of models was shown in the ante-room.

In Section G on Wednesday, September 11th, before commencing the regular business of the meeting, the President (Dr. Barr) announced that subscriptions for the proposed memorial to Lord Kelvin in Westminster Abbey had been coming in from all quarters of the globe, and it was now possible to make definite arrangements for a stained glass window, through which the light would fall upon the grave of Lord Kelvin. The Dean and Chapter of the Abbey had already agreed to this proposal.

The President moved that the hearty congratulations of the Section be extended to Sir Wm. White, K.C.B., F.R.S., on his election as President of the British Association for next year's meeting at Birmingham. He felt that the Section was also to be congratulated on being represented in the highest office by such an eminent and devoted member, and next year's meeting should prove to be a memorable one to engineers.

Prof. Coker then read his paper on "The Determina- of the Stresses in Springs and other Bodies by Optical and Electrical Methods." The optical method was to exhibit, by means of models made of xylonite or other sufficiently transparent material, the distribution of stresses in plate and volute springs, and the paper was illustrated by lantern slides which showed the stresses in a wonderfully satisfactory manner.

The second method was to exhibit the stresses in various parts of an actual steel I-beam by a very delicate determination of the changes of temperature in the various parts of the beam. In the electrical (temperature) method he could measure exactly to $\frac{1}{200}$ of a degree. A very thin layer of varnish or paper was used as insulation between the thermo-couple and the scraped steel surface of the beam being tested.

The next paper was by Mr. Bernard P. Haigh, of the Glasgow University, on experiments carried out there. The paper was entitled "Alternating Load Tests," but the loads were really repeated tension stresses, the wires not being subject to compression.

The tests were not prolonged fatigue tests, though these may be undertaken with the same apparatus, but were directed to ascertaining the effect of loads of uniform magnitude being repeated with high frequency over quite a short period.

The apparatus for applying the stress to wires of small diameter, which was shown at work upon the lecture table, was an electromagnet supplied with alternating current.

It was found that stresses upon mild steel wire amounting to 10 per cent. less than the real elastic limit could be repeated 2,000,000 times without elongation of the specimen, but if the full elastic limit were repeatedly applied, extension at once took place. Hard steel wire such as is used in steel wire ropes was found to show the least susceptibility to repetition of the safe load, being nearly as strong under repeated loads as under one normal load.

This method appears to offer immense possibilities for fatigue and vibration tests upon all sorts of materials. A device on similar lines invented by Prof. Kapp was described in our issues of January 12th and June 21st, 1912.

Prof. Ernest Wilson next read a paper on "Exposure Tests of Light Aluminium Alloys," showing the loss of electrical conductivity in wires exposed for long periods on the roof of King's College. The results were by no means encouraging for the use of aluminium for electrical conductors. An abstract of the paper appears on a later page.

The next paper, by Mr. R. S. Whipple, of the Cambridge Scientific Instrument Co., on the Féry bomb calorimeter, is of great interest to all buyers of coal, especially central station engineers. This very accurate and handy instrument was shown on the lecture table, the readings being thrown by a mirror on to a large scale for the demonstration. It was shown that by its use the fuel value of any coal could be ascertained in five minutes.

The next paper was by Dr. T. F. Wall on "The Hysteresis Loss in Iron due to a Combined Pulsating and Rotating Magnetic Field," and was ably summarised in the absence of the author by Prof. G. W. O. Howe.

A report on "The Importance of Previous Magnetic History to Engineers," was passed over in the absence of the author, only the title being read, and this only just left time, in a busy morning, for a beautiful demonstration by Mr. C. E. Larard with the kinematograph at the Palace Electric Theatre. Mr. Larard showed on the kinematograph and described torsional and extension tests in a Wicksteed testing machine. He also showed autographic test diagrams extending over long periods. By extending the time of the test to 10 hours, the yield point almost disappears, a diagram being obtained which is almost a regular curve.

The test exhibited on steel test pieces of 3 in. diameter extended for upwards of half an hour, and by means of the kinematograph 15,000 photographs were taken. The behaviour of a square bar being twisted to destruction was very striking, and in all cases the enlarged views of the test piece itself under the test were of quite extraordinary interest and beauty. Unfortunately, the hour was late and the audience small.

An extended use of the kinematograph for scientific demonstrations would not only assist the man in the street to understand many difficult problems, but would also undoubtedly disclose to the man of science many important features of the experiment which otherwise he might miss.

At the conclusion of the meetings of Section G, Mr. Chas. Hawksley moved a vote of thanks to Dr. Archibald Barr for so ably presiding over the meetings, and congratulated him on their marked success. The vote was carried with loud applause.

The whole of a very full programme of papers of a very valuable character had been worked through with the minimum of "drive" and hurry, and the only drawback to Dr. Barr's presidency was that he did not allow himself time to contribute at any great length to the discussion.

Note on the Gas Turbine.

By Dugald Clerk, D.Sc., F.R.S., M.Inst.C.E.

(*Section G. Abstract.*)

Many attempts have been made to produce a commercial gas turbine. So far, no attempt has succeeded; the practical difficulties have proved to be too serious. Much useful knowledge, however, has been obtained by able and adventurous experimenters. The late M. Réné Armengaud, together with M. Lemale, built in 1906 two experimental gas turbines of the constant-pressure type, one of

which developed 30 B.H.P. and the other 300 B.H.P. A gas turbine of the explosion type, without compression, was built by M. Karovodine, in 1907. It gave 1·6 B.H.P. at 10,000 R.P.M. Recently the explosion type has been studied by Mr. Hans Holzwarth, who has built a gas turbine of a rated power of 1,000 H.P., the wheel of which rotates at 3,000 R.P.M.

In a paper written by M. Réné Armengaud, and published in *Cassier's Magazine* in January, 1907, the inventor gives an interesting account of his experimental work on the constant-pressure turbine. A small experimental machine, it appears, was made by altering a De Laval steam turbine of 25 H.P., so as to operate it with compressed air instead of steam. The air was supplied at the desired pressure from a high-speed compressor, whose efficiency had been carefully determined. The compressed air was passed into a combustion chamber with measured quantities of gasoline vapour, and the mixture was ignited as it entered the chamber by an incandescent platinum wire. The combustion was then maintained continuously at a constant pressure. The combustion chamber was lined with refractory material, ultimately carborundum, and a temperature of about 1,800° C. was maintained at the flame, but the mean temperature of the discharging gaseous contents of the chamber was reduced to 400° C. by the admixture of steam under pressure. This steam was generated in a coil embedded in a portion of the combustion chamber. The working fluid thus consisted of a mixture of products of combustion and steam at the low temperature of 400° C. The constant pressure maintained in the combustion chamber was about 10 atmospheres, and the hot gases were allowed to expand through a conical Laval jet in which the expansion produced a high velocity, and reduced the temperature of the fluid. At this reduced temperature and high velocity the gases impinged upon the Laval wheel, and rotated the wheel in the same way as steam would have done. The experiments showed that under these conditions the total power obtained from the turbine separate from the compressor was double that necessary to drive the compressor.

In the large 300-H.P. turbine the first part of the combustion chamber was lined with carborundum, backed by sand, but the second part was surrounded by a coil through which water was circulated. The water kept the temperature of the combustion chamber within safe limits, and after absorbing heat, it passed also around the jet nozzle, and was discharged into the passage leading to the jet, and there converted into steam by the hot gases. A mixture of products of combustion and steam thus impinged upon the turbine wheel. The expanding jet was arranged to convert the whole of the energy into motion before the fluid struck the wheel; the temperature was thus reduced to a minimum before the gases touched the blades. Notwithstanding this, the wheel itself had passages through which cooling water flowed, and each blade was supplied with a hollow into which water found its way. In the large turbine the compressor was mounted on the turbine spindle; it was of the Rateau type, and consisted of an inverted turbine of four stages, which delivered the compressed air finally to the combustion chamber at a pressure of 112 lb. per sq. in. absolute. The efficiency of this turbine compressor was found to be about 65 per cent. The total efficiency of the combined turbine and compressor was low, as the fuel consumption amounted to nearly 3·9 lb. of petrol per B.H.P.-hour. An ordinary petrol engine with a moderate compression can readily give its power at the rate of 0·5 lb. of petrol per B.H.P.-hour. The combined turbine and compressor was stated to have run at 4,000 R.P.M., and to have developed 300 H.P. over and above the negative work absorbed by the compressor. Notwithstanding the high fuel consumption, it was a notable achievement to obtain 300 H.P. from an internal combustion turbine under any circumstances, and had it not been for the untimely death of M. Armengaud this turbine might have been greatly advanced.

The explosion gas turbine invented by M. Karovodine was exceedingly ingenious. It contained four explosion chambers having four jets actuating a single turbine wheel, which wheel was of the Laval type, about 6 in. diameter, having a speed of 10,000 R.P.M. The explosion chambers were vertical, and had a water jacket surrounding the lower end. The upper portion contained the igniting plug on one side, and the discharge pipe connecting with the expanding jet on the other. In the lower water-jacketed part there was provided a circular cover, held in place by a screwed cap. This circular plate was perforated with many holes, and it carried a light steel plate valve of the flap or hinging type, which pulled down by a spring contained within the admission passage. This spring could be adjusted, and the lift of the valve was regulated by means of a set screw passing diagonally through the water jacket. Air was admitted at one side by a pipe leading into the valve inlet chamber, and a corresponding passage or pipe admitted petrol and air or gas to mix with the air before reaching the thin plate valve. Adjusting contrivances were supplied in both air and fuel ducts. To start the apparatus, an air blast was forced through the valve, carrying with it sufficient petrol vapour to make the mixture explosive. The electrical igniter was started, and the spark kept passing continuously. Whenever the inflammable mixture reached the upper part of the combustion chamber ignition took place, and the pressure rose in the ordinary way, due to gaseous explosion. The gases were then discharged through the pipe and nozzle on to the Laval wheel. The cooling of the flame after explosion and the momentum of the moving gas column reduced the pressure within the explosion chamber to about 2 lb. per sq. in. below atmosphere. Air and petrol vapour then flowed in to fill up the chamber, and as soon as the mixture reached the igniter, explosion again occurred. In this way a series of explosions was automatically obtained, and a series of gaseous discharges was made upon the turbine wheel. Diagrams taken from the explosion chamber showed a fall in pressure during suction of 2 lb. per sq. in.; ignition occurred while the pressure was low, and the pressure rapidly rose to about 1½ atmospheres absolute. The pressure propelling the gas column and jet was thus only 5 lb. per sq. in. above atmosphere. The pressure rapidly fell, and the whole process was repeated again. According to the diagrams taken, a complete oscillation required about 0·026 second, so that about 40 explosions per second were obtained.

Mr. Suplee, in his interesting work upon the gas turbine, describes experiments made by M. Baudezat on a turbine of this type. The volume of one chamber was 230 cb. cm. Each nozzle was 3 m. long and 16 mm. diameter. The wheel itself was 150 mm. in diameter, or 5·9 in. It made 10,000 R.P.M., corresponding to a perimeter velocity of 78½ metres, or 258 ft. per second.

This experiment gave 1·6 B.H.P., and Mr. Suplee takes the wheel and journal friction as 0·5 H.P., so that the equivalent power was 2·1 I.H.P. The fuel consumption was nearly 6·5 lb. per B.H.P.-hour. The little explosion turbine thus consumed more than double the petrol required per horse-power by the large constant-pressure turbine.

The large Holzwarth gas turbine also operates on the explosion principle, but the construction and action is very different from that of M. Karovodine. The turbine in general arrangement outwardly resembles the Curtis steam turbine, in that the turbine wheel rotates in a horizontal plane, the spindle or shaft is vertical and a dynamo is mounted on this spindle above the turbine. In the Holzwarth turbine ten combustion chambers are provided, each of a pear or bag shape. They are arranged in a circle around the wheel, and are cast so as to form the base of the machine. The wheel is of the Curtis type, with two rows of moving and one row of stationary blades. Mr. Holzwarth does not give the dimensions of his turbine wheel, but from the drawings and some of the velocities given by him it appears to be about 1 m. in external diameter. The lower part of each combustion chamber carries gas and air inlet valves, and the upper part carries a nozzle arranged to cause the gases to impinge upon the first row of moving blades. This nozzle is connected to and disconnected from the combustion chamber by means of an ingeniously operated valve. The explosion chambers are charged with a mixture of gas and air, which appears to attain a pressure of about two atmospheres within the chamber before explosion. The air and gas are supplied under sufficient pressure from turbine compressors, actuated by steam raised from the waste heat of the explosion and the gases of combustion, so that whatever work is done in compression is obtained by this regenerative action, and does not put any negative work upon the turbine itself. The combustion chambers are fired in series, by means of high-tension jump spark ignition. The action is as follows: Air is caused to flow through the combustion chamber to sweep out the products of the previous explosion, and also to assist in cooling the wheel by impinging upon it. The nozzle valve is closed, then gas is forced in to produce the explosive mixture. Gas and air valves are both closed, and the electric spark is passed. The pressure of the explosion opens the nozzle valve, and the gases acquire velocity within the nozzle, the temperature falls, and the high-velocity lower temperature gases impinge upon the wheel. As the pressure falls, the nozzle valve gradually closes, but remains open until the scavenging and cooling current has been passed through. When closed, the charging proceeds and explosions occur as already described.

Many practical difficulties were found, but ultimately the turbine was operated by producer gas made from coke. It was found that when all 10 chambers were in operation the maximum pressure on explosion which could be obtained with the best mixture was only about 45 lb. above atmosphere. Using five combustion chambers, the best explosion pressure varied between 80 lb. and 90 lb. per sq. in. above atmosphere; while with four chambers, the highest result obtained was 105 lb. per sq. in. So far as I understand Mr. Holzwarth's experiments, the highest power actually obtained was about 160 B.H.P. (according to latest news, now 450 H.P.). In this experiment 10 chambers were used, giving 16 H.P. each. With five chambers, a total of 145 H.P. was obtained, at 29 H.P. per chamber; and with four chambers, the total was 121·6 B.H.P. at 34 H.P. per chamber. With 10 chambers in operation the power fell to about one-half per chamber, as compared with four chambers. From these experiments Mr. Holzwarth came to the conclusion that the successive explosions interfered with each other, and prevented proper charging and action. Obviously with the arrangements used in the experiments, 10 chambers were inadmissible.

Notwithstanding the unsatisfactory results of those experiments, Mr. Holzwarth is to be congratulated upon his courage and perseverance in attempting to solve a very difficult problem on so large a scale.

The existing internal-combustion engines are quite satisfactory for small and moderate power units; but the weight increases so rapidly with increase of cylinder diameter that large units, such as 20,000 H.P. per shaft, easily attained by the steam turbine, have proved quite impossible for the reciprocating gas engine. In order to apply internal combustion for the parpose of such large units, it appears to me to be necessary to dispense with the cylinder, piston and crank. I fear that this cannot be done on the lines of either constant-pressure or explosion turbines here shortly discussed. The results obtained only appear to show that progress can hardly be expected on the lines of flame impinging on turbine blades, either in impulse or reaction turbines. Several engineers have suggested the use of explosion to give water velocity, which velocity actuates a water turbine in some form. Mr. Humphrey figures such a combined gas and water turbine; and although in the form suggested by him the conditions required too cumbrous a machine, yet it does seem to me that the more hopeful line is to use explosion and expansion to give water velocity, and so avoid all heat difficulties

in the turbine part of the apparatus. It is true that such an arrangement still necessitates a reciprocating mass of water, but it will probably be found that great gain in weight can be obtained by the suppression of the piston, connecting rod, engine frame and crank. This line seems to me to be a much more hopeful one than any scheme involving the direct contact of flame with turbine blades.

After reading his paper, Dr. Dugald Clerk said that Mr. Holzwarth had, unfortunately, been unable to attend. He had, however, telegraphed to him that morning giving the latest test on the big gas turbine which had been designed for 1,000 H.P. The highest brake

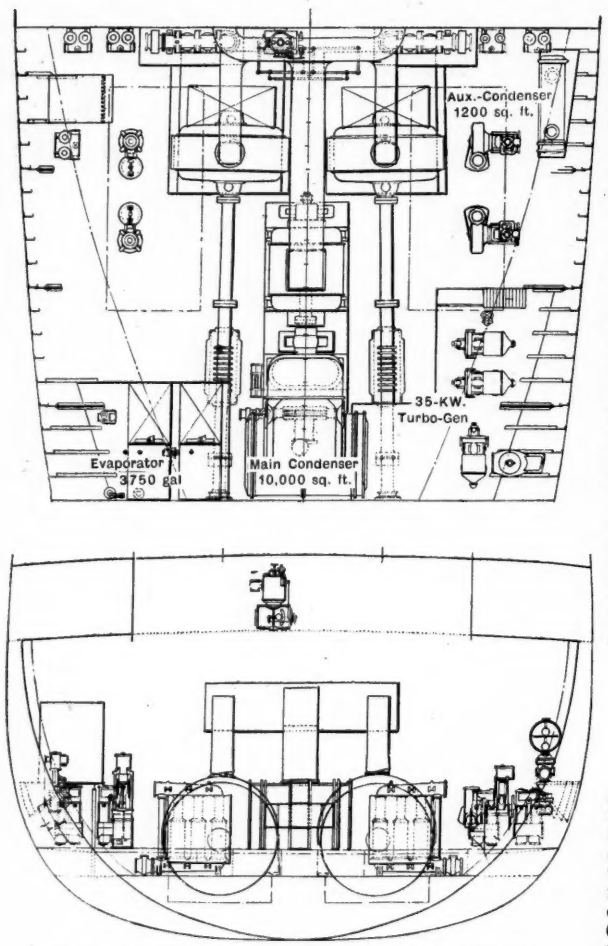


Fig. 1.—Arrangement of Machinery in U.S. Collier "Jupiter."

horse-power actually realised to date was 450, and the best all-over efficiency 23 per cent., but it was not stated if this was indicated or on the brake. Mr. Holzwarth referred to his latest published tests as being dated June 13th this year. Dr. Clerk showed sketches of the Armengaud gas turbine referred to in the paper, and mentioned that a part of the explosion chamber had been lined with carborundum. It was really a mixed turbine, highly superheated steam being mixed with the gas resulting from the explosions, and the mixture being projected against the turbine blades. Dr. Clerk's own opinion was that the problem was most likely to be solved by using some other working fluid such as, for instance, water, with the gas.

Sir Wm. White said that no one would like to go back to the reciprocating principle for big marine work, the control and management of turbine engines at sea was so much easier. One had only to compare the main (turbine) engine room of the *Mauritania* with the auxiliary (reciprocating) engine room to realise the vast advantage of the turbine, especially in a heavy sea. With regard to Diesel engines, he had lately travelled 100 miles in the sister ship to the *Selandia*, and could not help admiring the cleverness of the Danish engineers in overcoming mechanical difficulties. He agreed with Dr. Clerk that the vanes of the turbine must not be subjected to high temperatures.

Prof. Silvanus P. Thompson said a temperature of 1,800° was impossible for metal blades. The jet should be reduced below red-heat, say to 400° F. With regard to the carborundum lining to the combustion chamber, he would have thought it would break up under the repeated blows of the explosions and be blown amongst the vanes. He understood that Mr. Ferranti was working at the problem, but as yet he knew nothing of the results.

Sir Alfred Ewing, F.R.S., endorsed what had been said as to the enormous advantages of turbine driving on board ship. He thought a solution of the problem would be reached most speedily by finding a new material for the turbine blades.

Dr. Robert Mond referred to the splendid perseverance of Mr. Holzwarth. The difficulties to be overcome were immense. Mr. Herbert Humphrey had tried an explosive gas engine with two cylinders side by side and a small cylinder between. He had made an attempt with a separate explosion cylinder. That engine required another engine to turn it round. In his opinion, the separate explosion cylinder was no good. He had tried a rotatory type of engine, but the difficulty was to get it steam tight. When it was tightened up it was too stiff to work. He believed it was only a question of time till they had the steam turbine generally at work. The engines should be built to suit the ship instead of the ship to suit the engines.

Mr. F. Samuelson thought it would be better to turn our attention to improving the overall efficiency of the steam turbine. With steam turbines, an overall efficiency of 18 per cent. to 20 per cent. could be secured, and with Diesel engines, 30 per cent. Some considerable advance would be made if we could have pressures of 400 lb., and superheat temperature of 750° F. If the overall thermal efficiency could be brought up to 22 per cent., it would mean 20 per cent. saving in coal. In his opinion the high price of oil fuel would prevent the Diesel engine from displacing the steam turbine, which he regarded as likely to live for many years yet.

Dr. Dugald Clerk, in reply, said that in the Holzwarth combustion chamber, there was no very definite explosion. It was practically maintained at constant pressure. Parsons and Curtis, and other turbine inventors, had not been blind to the advantages of much higher pressures and temperatures; but it had been found that the cast-iron casing loses its "nature," and eventually fails at temperatures over 600° F. It was necessary to realise the temperature of the steam before it reached the turbine. If a new metal could be discovered which would stand the temperatures as suggested by Sir Alfred Ewing (Sir A. Ewing interjected that he did not say "metal," but "substance") the problem might be solved. After all, the gas engine proper would be difficult to displace. Gas engines were now being made up to 1,500 H.P. in single units. The present coal supply of the world was eleven hundred million tons a year, and the oil supply only 45 million tons, or not much more than 4 per cent. of the coal supply, and it must not be overlooked that of that quantity of oil a large proportion was used for lighting and for the making of lubricants and for other purposes, only a small proportion being used for oil engines. At present it would require far more than all the oil available to run the navies of the world alone. A vote of thanks to Dr. Dugald Clerk was moved by Dr. Barr, who remarked on the splendid progress already made, in spite of very serious difficulties.

Marine Propulsion by Electric Transmission.

By Henry A. Mavor.

(*Section G. Abstract.*)

At the Portsmouth meeting of the British Association in September, 1911, the present writer submitted a communication on "Electric Drives for Screw Propellers." Since that date some further developments have occurred. The first of the three propositions of which details were given has been superseded by an ordinary reciprocating engine equipment. The second proposition, an oil-electric tank barge for Canadian service, is now under construction (the details of the machinery equipment form part of this communication). The third proposition is still on paper only, but the United States Government has ordered an equipment closely resembling that described. This equipment has been constructed by the General Electric Co., of America. Descriptions of this plant have already been published by Mr. W. L. R. Emmet, the designer and are here summarised.

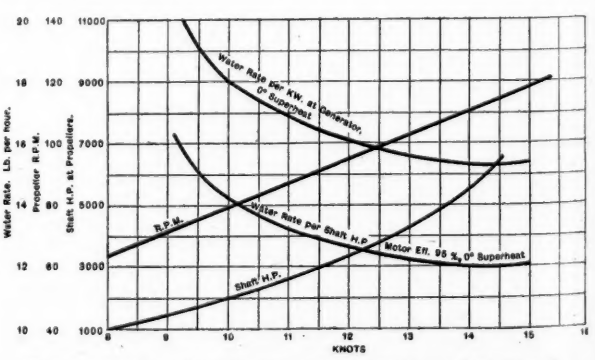


Fig. 2.—Performance Curves, U.S.A. Collier "Jupiter."

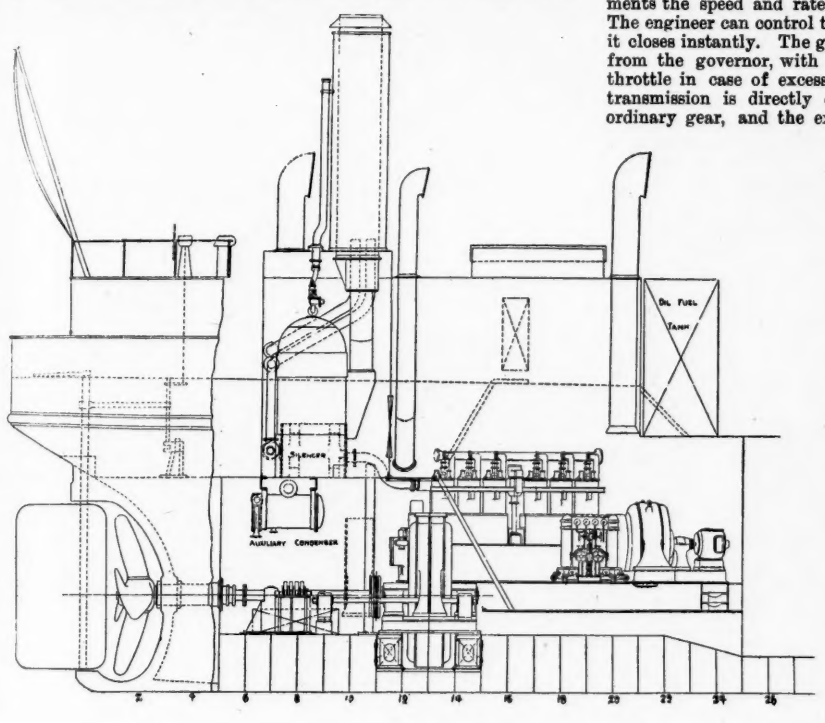
The *Jupiter* is one of three colliers being built for the United States Government. They are to be called *Cyclops*, *Neptune* and *Jupiter*. The *Cyclops* is equipped with reciprocating engines, the *Neptune* with a steam turbine connected to the propellers by gearing, and the *Jupiter* with a steam turbine connected to the propellers by electric transmission. These ships have a displacement of about 20,000 tons and carry something like 12,000 tons cargo. The speed is 14 knots. The *Cyclops* has already been tried

on a 48-hour trial at an average speed of 14·6 knots, with a coal consumption, for the main engines only, of 1·485 lb. per I.H.P.-hour, the total average I.H.P. of both engines for the run being 6,705, and the average rate of propeller revolution 92 per minute.

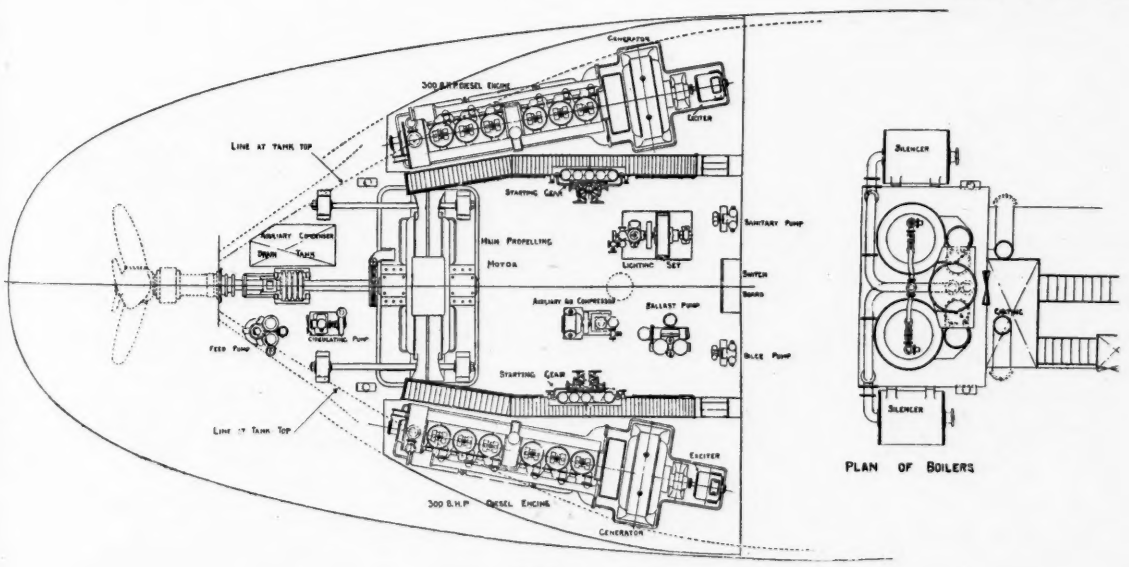
The trials of the *Neptune* are not yet complete. It is reported that the gearing works in an entirely satisfactory manner, but that the efficiency of the turbine and propellers has not yet proved so good as expected.

The collier *Jupiter* is being built at the Mare Island Navy Yard. The electric propelling machinery is now complete and has been tested in the shops. The generating unit consists of a six-stage Curtis turbine connected to a bipolar alternator; the speed of the generator at 14 knots is about 2,000 R.P.M., and the voltage about 2,200. This generating unit delivers electricity to two motors, one coupled directly to each propeller shaft. These motors have 36 poles; therefore the ratio of synchronous speed reduction is 18·3 to 1, the propeller at 14 knots being designed to operate at 110 R.P.M. (The *Neptune* speed ratio is from 1,250 to 135, or 9·25 to 1.) The connection between the parts of the electric equipment is provided by a switchboard arrangement with oil switches for connecting the motors for either direction of rotation, and with apparatus to show and record the electric power delivered to the motors. There are also two special resistance devices for use in circuit with the revolving part of the motors during the processes of reversing. The generating unit and motors are self-lubricating and self-ventilating. Sheet-metal ducts are to be connected to the air outlets, and the heated air will be led to the suction of the stokehole blowers. The speed of the motors in this vessel will be changed by variations in the speed of the generating unit, the ratio of speed reduction remaining fixed. These changes are accomplished by means of a governor of novel construction, so arranged that it is capable of automatically holding the speed at any point from about 5 to 14 knots. The setting of this governor is controlled from the switch platform, and the operating engineer, without changing his position, can run the vessel at any speed ahead or astern, and can stop and start, and read on his instruments the speed and rate of power delivered to each propeller. The engineer can control the main throttle valve or trip it so that it closes instantly. The generating unit is also equipped, separate from the governor, with an automatic device to trip the main throttle in case of excessive speed of the turbine. The electric transmission is directly comparable in function to that of an ordinary gear, and the experimental comparison which is being here made will be of value in estimating the relative effectiveness as well as efficiency of the two new methods. The methods used on this ship constitute the simplest known form of electric power transmission, in many respects novel in the detailed arrangements, but, broadly speaking, the plant is designed and built on exactly the lines on which the General Electric Co. have carried out work on a very extensive scale and for a great variety of purposes on shore under conditions far more complicated and difficult, and with immunity from trouble. In the many years of production of alternating apparatus of this type there has hardly been a case recorded of insulation failure, and it is claimed that in this respect the record of the electrical part of the equipment is superior to the record of any other type of apparatus which has hitherto been used for ship propulsion. An illustration showing the arrangement of the plant in the ship accompanies this paper (see fig. 1, page 448).

The writer saw this plant officially tested at Schenectady in the summer of this year. For the purpose of the test, the apparatus was erected in the General Electric Co.'s power station at Schenectady. The turbine was connected to a condenser, and one motor installed in the position relative to the switchboard and controlling mechanism which it will occupy on board the ship. The other motor was arranged as a generator, and directly coupled to the first motor, so as to afford a load for it. With this generating motor as load, the conditions of service can be approximated, although they are more difficult than the driving of a propeller, because the load falls off only slightly with diminutions of speed and constant exciting current. With the apparatus so installed, the processes of starting, stopping, speed variation and reversal can be accomplished very much as they would be on board ship, and the time and difficulty involved can be cor-



SECTIONAL ELEVATION



PLAN OF BOILERS

PLAN

FIG. 3.—SHOWING ARRANGEMENT OF OIL-ELECTRIC PROPELLING MACHINERY.

rectly judged. The motor can be operated at its full load or any desired proportion of its load, and at any desired speed. Variation is accomplished by a mechanical action of the governing mechanism of the turbine equivalent to that which would be used on board ship. These arrangements afford means of experimenting with the operating conditions up to about half load, the work being applied to one motor only, and the second machine being used as a generator, the current from which is carried to an artificial resistance for absorbing the energy. This device is necessary because the absorption of 7,000 H.P. on the propeller shaft is beyond the resources of existing mechanical power-wasting devices. On the other hand, it is easy to provide means of ascertaining the working conditions as applied to the generating unit, because it is easy to absorb the power of the electric generating unit in artificial water resistances. The water rates of the generating unit have thus been tested in all loads and conditions, and the record of these tests is shown by the accompanying curves (see fig. 2, p. 448). In these tests the effects of speed, voltage, vacuum and superheat are all thoroughly investigated in a series of tests run under the conditions of load characteristic of the ship's operation. Experience gained on these tests has suggested modifications by which it is anticipated that the rate can be reduced from 12 lb. to 11½ lb. of steam per shaft H.P.-hour.

The following operations were carried out in the shop trials: (1) Start turbine by opening trottle, the speed being shown by an indicator on the switchboard. (2) Bring turbine to moderate speed by movement of dial controller; adjust the motor resistance and start the motor by closing "ahead" switch. (3) Reverse the motor repeatedly by simply throwing over the switches with the speed and load corresponding to about 8 knots. (4) Increase the speed and adjust the load to correspond to the maximum which can, with the normal speed and voltage of the generator, be run with resistance in, this being the maximum speed which would ordinarily be used in "backing and filling." (5) Cut resistance out of circuit by slowing down the generator, opening the field, throwing a resistance lever and again closing the field switch. (6) Increase the speed to 14 knots and adjust the load to correspond. (7) Reduce the load to about half that which corresponds to the maximum load on the ship after reversal; then reverse the motor by interrupting the field, throwing the resistance lever, change from "ahead" to "reverse" position of the switch and again close the field. (8) Stop the motor and start with resistance. (9) Reverse with resistance.

These operations cover all the conditions likely to be met with in service, and all of them were repeated and varied, showing complete facility of handling the equipment. The reversal particularly was easily and smoothly accomplished. The writer took no specific records of the time required to produce the reversal. This would require special apparatus, because it was so short that it could not be conveniently observed by means of a stop-watch and visual observation.

In the writer's preliminary studies on this question he considered it necessary to deal with the question specially from the point of view of propeller efficiency. Further experience has shown that in most of the cases with which he has been called upon to deal, the propeller conditions are determined by the conditions under which the ship has to work in respect of draft, &c., so that there are not many cases where the saving in propeller efficiency is a fundamental determining factor in the choice of electric equipment.

Returning to the Canadian vessel, the arrangements shown in the drawings accompanying the writer's paper to the Association at Portsmouth last year have been somewhat modified in carrying them into actual form. It has been found more convenient to arrange the generating plant in two units, as shown in the drawings herewith (see figs. 3 and 4). The general principle of the apparatus is as described in last year's paper. This is one of the cases where the limitations imposed by the conditions of service are such that the best results are obtained by adopting the propeller size and rate of revolution which have been determined by experience in working with steam. The present arrangement results in an increase of about 250 tons in the carrying capacity as compared with the steam equipment; first, due to the absence of the boilers and consequent reduction in space and weight of machinery; secondly, due to the important difference in the heat value of the fuel and the efficiency with which it is used, so that the bunker capacity can be materially reduced.

The vessel as now designed has dimensions—

Length overall...	256 ft.
Length between perpendiculars ...	250 ft.
Extreme breadth	42 ft. 6 in.
Depth moulded...	19 ft.
Speed	9 knots.

The vessel is designed for and is estimated to carry about 2,400 tons dead-weight of cargo, fuel, fresh water and stores, on 14 ft. mean draft in fresh water. She is classified for service on the Canadian canals, Great Lakes, St. Lawrence river and gulf, with occasional trips to Sydney, Cape Breton.

It will be noted that two steam boilers are provided for the working of the deck equipment, steering gear and electric light, and for the supply of heat for the living quarters. It may at first sight seem out of place to return to steam equipment for these services, but the conditions of the service in question are such as to call for an auxiliary equipment at small capital cost. The season is short, and the amount of work called for from the auxiliary equipment is small, and therefore, although an electric equipment would be much more economical in working, there is not time or opportunity for the more economical plant to justify the increased capital expenditure, which is very considerable. The necessity for providing steam for heat has also a strong bearing upon the question at issue. If the steam boiler has to be used it involves but little additional expense to provide steam for the steering gear, electric light and whistle. The boilers are oil fired, and the fuel and working pressure are in perfect control. The same fuel is used in the boilers as in the internal-combustion engines.

The main machinery equipment is in two units, each consisting of an engine, dynamo and a winding on the propeller motor. The engine is of the high-speed type which has been developed by Messrs. Mirrlees, Bickerton & Day. Large numbers of these engines have been made, and their capabilities thoroughly demonstrated, so that there is little that is experimental in the use of this plant for the purpose intended.

The engine works on the Diesel four-cycle principle, and has the following main dimensions:—Cylinders, 12 in. diameter; stroke,

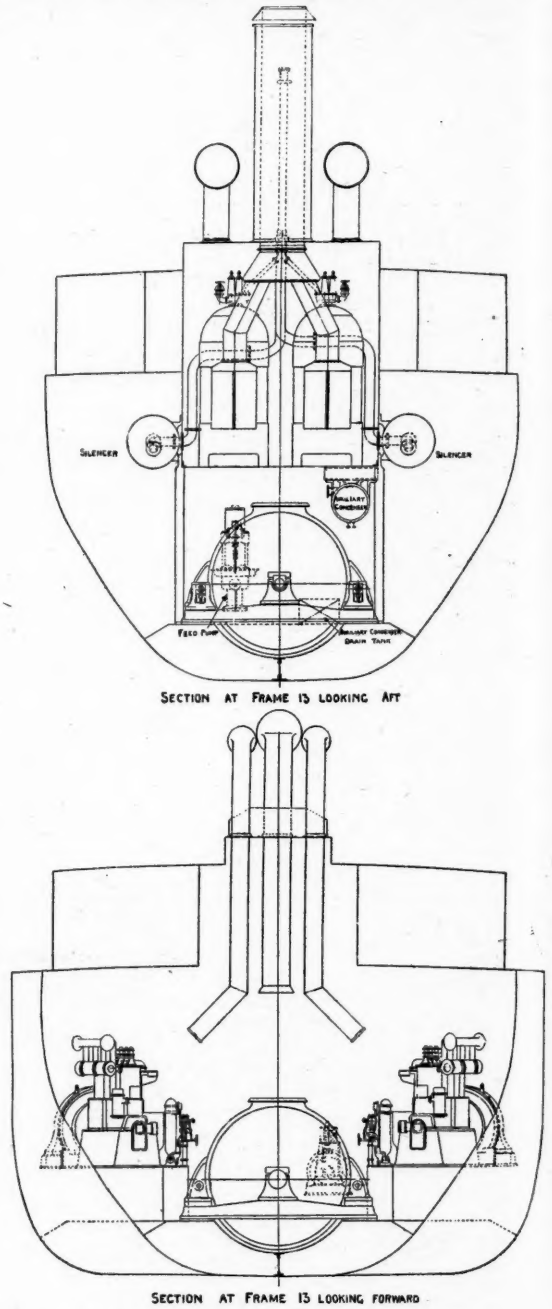


FIG. 4.—SECTIONS THROUGH OIL-ELECTRIC SHIP.

13½ in.; R.P.M., 400. There are six cylinders on each engine, and the cranks are so arranged that the firing takes place at equal intervals. The engine is mounted on a bedplate, on which are the columns carrying the cylinders, with their heads and valves. The cylinder head contains the valves, which are operated by levers and cams. A special feature of the levers for the air, exhaust and fuel cams is that they are split in such a manner that the part above the valves can be swung back and the valves can easily be removed without disturbing any other gear.

The working parts of the engine are entirely enclosed, and a system of forced lubrication is used, supplied by a valveless pump driven by an eccentric on the crankshaft, placed at the compressor end. The second motion shaft is driven by means of a worm wheel mounted on the crankshaft directly midway between the centre

cylinders through a vertical shaft, which also carries the governor at its upper end. On the second motion shaft, which is placed at the front of the engine and carries the cams for operating the valves, are mounted the eccentrics which drive the fuel pumps, there being a separate pump for each cylinder. This arrangement enables the power to be very equally divided between the cylinders. The compressor is driven directly from the main crankshaft, and is mounted in the bedplate, which is extended to carry it.

The starting of the engine is effected in the usual Diesel manner by means of compressed air stored in receivers placed in a handy position near the engine. The compressed air for this purpose is supplied by the compressor on the engine, which also supplies that required for blowing the fuel oil into the cylinders. The engine is provided with a patented device for preventing the accumulation of fuel oil in the fuel valves, which are inoperative during starting. A small fly-wheel is fitted of sufficient weight to ensure steady running and to facilitate barring round when required. It is bolted to a flanged coupling forged solid with the crankshaft.

Cooling water is circulated through the cylinder and compressor jacket by a pump of the rotary type, which draws direct from the sea. This pump is driven by mitre-gearing from the compressor end of the crankshaft. The exhaust pipes also are water cooled. The air for the main cylinders is drawn through the bedplate, thus effectually silencing the suction.

In the normal operation of the ship the engines run under governor control at 400 R.P.M., but the speed of revolution can be adjusted by manipulating the governor so that the engine may maintain constant revolutions per minute at a rate considerably below 400 should this be required.

The electric equipment consists of two three-phase generators, each giving about 235 K.V.A. at 500 volts alternating. The generators have six and eight poles respectively, giving frequencies of 20 and 26·6 per second. Connected to the shaft of each generator is an exciter which, in normal working, gives about 30 amperes at 100 volts, but is capable of a considerable overload. A single three-phase motor is coupled direct to the propeller shaft. This motor develops 500 shaft H.P. The rotor is of the simple squirrel-cage type without any electrical or mechanical connections other than its rigid attachment to the propeller shaft. The stationary part of the motor has two separate windings, for 30 and 40 poles respectively. The windings are mutually non-inductive, so that, except for slight possible leakage of magnetism, they exercise no influence whatever on one another, and operate independently on the magnetic circuit of the motor. When each of these two windings is connected respectively to the appropriate generator the synchronous speed due to each is 80 R.P.M., or actually about 78 R.P.M. when at full speed. By changing the connections the direction of rotation is reversed, and by connecting the 40-pole winding of the motor to the 6-pole generator the synchronous speed drops to 60 R.P.M., or actually to 58 R.P.M., giving about three-quarters of the full speed of the ship under this condition. One generator may be stopped and the other left running at full revolutions under governor control, and, therefore, at approximately its full economy, because the power required to drive the ship at three-quarter speed is about half of that required to drive it at full speed. If either of the generators is left attached to its own winding, the other generator being shut down either by intent or by accident, the ship is propelled by either engine at a little over half speed, the speed of the ship falling with the speed of rotation of the engine until an automatic adjustment of power and speed is reached. This occurs at about half speed.

The control gear is so simple as hardly to require any specific description. In the first instance it is not proposed to operate the control from the bridge, but arrangements are made by which this can easily be done if required. There are five positions on the switch corresponding to the ordinary positions on the engine-room "telegraph." They are "full speed ahead," "half speed ahead," "stop," "half speed astern," and "full speed astern." Each position of the controller is definitely fixed by means of cams and roller, so that stopping at intermediate positions is prevented. For half speed, No. 1 generator is coupled to No. 2 winding of the motor, and No. 2 generator is running light or stopped. For full speed each generator is connected to its own winding on the motor respectively. The controlling gear provides for the interruption of the excitation of the generators while the switch is being moved from one step to another. This mode of operation renders the electric circuits "dead" while the switching-over operation is being accomplished and thus injurious sparking is avoided.

It will be seen that in this case the control gear is somewhat different from that described for the *Jupiter*. In the *Jupiter* the motors are provided with wound rotors in which resistances can be inserted for control of the rotor currents. In the present case there is no such control. The rotor current is allowed to rise to the value determined by the properties of the motor and the mechanical resistance imposed upon it by the shaft. The control of this current is limited to what is obtainable by control of the exciting field of the generator.

A long series of trials was carried out on the experimental vessel *Electric Arc*, which was described by the writer in his communication last year, and on the data there obtained it has been found possible to design the equipment for this vessel so that it is equal in simplicity to the smaller experimental equipment. This vessel has been purchased by the Montreal Transportation Co. for service on the Canadian lakes. It is to be named *Tynemount*, and is being built by Messrs. Swan, Hunter & Wigham Richardson, to the order of the Electric Marine Propulsion Co. The writer desires to acknowledge the valuable co-operation of Mr. John Reid, of Glasgow and Montreal, in the design of this vessel and equipment.

Many other propositions are under consideration, but the policy of proceeding by successive steps towards the more important applications renders the rate of progress slow. The steps now made are from 50 to 500 and 5,000 H.P., so that not many more are required to demonstrate completely what are the capabilities of electric marine propulsion. It is to be hoped that this country may have the glory of making the next step. At present the credit of the largest equipment is with America.

SIR WM. WHITE, M.Inst.C.E., said he had no doubt that in certain cases electric transmission for ship propulsion would be advantageous. But the development would be gradual, and would be confined to certain classes of vessel. He admired the patience, moderation and skill which Mr. Mavor had for some years devoted to this subject. He himself had used a small electric launch built as a working model to ascertain the solution of some of the problems that had to be faced in the design of the *Mauretania*, and had found the electric drive very favourable to obtaining the required data. He had lately been in the States, where he learned all about the trials with the three naval ships referred to. The *Neptune* (with geared turbines) was now having her propellers altered in order to get a higher efficiency.

PROF. G. W. HOWE (London) pointed out that, with the arrangement of Diesel engines described by Mr. Mavor, the efficiency would be much more reduced by the breakdown of one of the two sets of engines than if the other were to stop.

PROF. MARCHANT (Liverpool) remarked on the saving of weight that might be effected by the use of very high-speed engines with electric transmission.

MR. MAVOR, in reply, said he could not admit that there were any disadvantages about electrical transmission. The system cost about 10 per cent. more than direct driving systems in initial outlay, and that was the great obstacle to its general adoption for certain sizes of vessels. As compared with a reciprocating engine set, the saving in weight was important. With the steam engines or turbines themselves the best chance to save weight lay in the direction of high superheat. With very large vessels designed for high speeds he did not think electrical transmission would beat the direct-driving turbine in economy or in any other way. On the other hand, for moderate displacements and speeds the economies to be effected fully justified the adoption of electrical transmission; and, where gear was to be used, it was the most efficient gear, and it was no more expensive than mechanical gear.

DR. ARCHIBALD BARR, M.Inst.C.E. (the President of the Section), in moving a vote of thanks to Mr. Mavor, said he was delighted to hear of the progress being made.

Exposure Tests of Light Aluminium Alloys.

By ERNEST WILSON.

(*Section G. Abstract.*)

THE physical properties of certain light aluminium alloys have formed the subject of several communications, and as stated therein each alloy has been suspended on the roof of King's College, London, in order to investigate the influence of exposure upon electrical conductivity. All the specimens are in the form of wire 0·126 in. (3·2 mm.) in diameter, and all the resistances are reduced to 15° C.

It has been pointed out that alloying commercial aluminium with copper alone has proved unsatisfactory, as a 2·6 per cent. copper alloy had completely deteriorated in 10 years and increased its electrical resistance 25 per cent.

An increase in the percentage of the iron always found in commercial aluminium, or the addition of nickel or manganese to an alloy containing about 0·09 per cent. of copper, has beneficial results both from the standpoint of tensile strength and the power to resist deterioration. For example, specimens containing, respectively, 1·16 per cent. iron, 2·25 nickel, and 1·78 manganese have only increased their electrical resistance about 9 per cent. in 11 years.

"Duralumin" is a copper-manganese alloy of aluminium with the addition of about 0·5 per cent. magnesium. A specimen about 80 ft. long has been exposed one year, and has increased its electrical resistance 5·15 per cent. It would be interesting to know if this is due to the comparatively large percentage of copper (3·5 to 5·5) which this alloy is stated to contain, or if the percentage of manganese (0·5 to 0·8) is too low. This alloy has attracted attention in that a breaking load as high as 90,000 lb. can be obtained, if desired, according to treatment; but as an electrical conductor it does not compare well, since the specific resistance is about twice as great as that of commercial aluminium.

A specimen of high-conductivity copper about 80 ft. long has been exposed for one year, and has increased its electrical resistance 1·2 per cent.

MR. ARNOLD LUPTON referred to Messrs. Vickers's alloy "Duralumin," and asked whether there was much salt in the atmosphere at King's College, as salt was known to be very destructive to aluminium and its alloys.

PROF. PETAVEL remarked that "Duralumin" had very fine properties, but was unfortunately very delicate as regarded heat, and most susceptible to sea atmosphere, and exact homogeneity of the material was difficult to obtain. It was, strength for strength, five times lighter than steel.

PROF. ERNEST WILSON, in reply, said there was practically no salt in the atmosphere at King's College, but a good deal of sulphur. Aluminium had been found very risky for yacht building, as if the protective covering were scratched off, the material was very rapidly attacked by the salt water. In jointing aluminium, copper must never be used, because of the galvanic action which would be set up.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Mining Electric Lamps.

We thank you for your very kind notice of the "Stach" electric mining lamp in the issue of the 6th inst., but we venture to object mildly to one or two statements contained in your articles.

In a leaderette on page 362 you say:—"From the descriptions of the two lamps in this issue, it will easily be seen why the 'Ceag' is the better." With regard to this statement, we would inform you that we do not consider that the "Ceag" is better in respect of anything except price, and this, of course, counted in its favour in the competition.

At the end of your second article, on page 368, you state that the weight of the "Stach" lamp is about 6 lb., and the weight of the "Ceag" lamp is stated on page 366 to be a little over 4 lb. As a matter of actual fact (the writer having personally weighed one of each), the weight of the "Stach" lamp is 5 lb. 7½ oz., and the weight of the "Ceag" lamp is 5 lb. 1½ oz.

As to the rest of your comments, we have no remarks to make, but these two points are facts, and we think it right to draw the attention of your readers to them.

The Electrical Co., Ltd.
A. J. CRIDGE (Meter Department).

London, W.C., *September 10th*, 1912.

Earthing in Mines.

Mr. Walker's plea in last week's ELECTRICAL REVIEW for the abolition of earthing in mines is not likely to commend itself to many mining or electrical engineers. The title of his letter, "Insulation *v.* Earth," is itself sufficient to show the fallacy of his position. There is nothing antagonistic between insulation and earthing; they are respectively our first and second lines of defence against shock and fire, while earthing is an essential part of the "efficient means" which Rule 7 (*d*) of the Home Office new code requires "to be provided for immediately indicating any defect in the insulation of a system."

A system with inferior insulation may be perfectly safe if the earthing is sound. A failure of the insulation will operate the breakers or blow the fuses, but the earthing can, and should, be made to prevent any possibility of shock. On the other hand, it is never safe to trust to insulation alone; at the best, it is liable to be damaged by some external cause, *e.g.*, a fall of roof. There is a long list of fatal accidents resulting from tubs or other moving gear cutting through cable insulation, all of which would have been prevented if the cables had been provided with earthed armour. If there is no earthing system, any metal work in the mine may become "live," and remain so unsuspected, ready to give a fatal shock to the first man who touches it.

To say that insulation can be made a certainty, and that earthing at best is more or less of an accident, is surely a misstatement of the case. All insulators are of a delicate nature, either brittle or friable; most are affected by heat and damp. All insulation in a mine is covered, out of sight, and cannot be inspected. However well made the windings of a motor may be, the insulation is liable at some time to succumb to the combined effects of vibration, rough handling, heat, damp, dust and oil, and fail without warning. On the other hand, the materials used for earthing are metallic, and can be chosen to resist chemical or mechanical damage. All earthing conductors can, and should, be made mechanically strong, and be kept uncovered and in full view. Their general condition can then be ascertained at any time with no other apparatus but a lamp and a good pair of eyes. Regular measurements of the conductivity should also be made, which will detect any loose joints or reduced cross-section. What is there of haphazard in such a system? After making a joint in armoured cables there is no difficulty in securing continuity of the sheathing. An armour clamp at each end of the "clumsy mass," with a piece of bare copper wire connecting the two, will do all that is required.

There is no practical difficulty in having every scrap of live metal—cable conductor, switch, terminal, motor winding, connector or meter—completely enclosed with its insulation in a strong metal sheathing of some sort, nor in making and maintaining complete continuity between all the sheathings, nor in making them with a conductivity at all parts equal to that of the largest conductor they enclose (or half this for cables), so that they will carry current enough to blow the fuse and make a fault dead directly it develops. There is no real practical difficulty in connecting all these sheathings through the shaft cable armour to an efficient earth plate at the surface, and also, if thought desirable, to other earth plates in the mine itself. If the earthing is done on this plan, and the mid-voltage point of the electrical system is also connected to the earth plates mentioned above (not to a separate one), there will be no need of local earthing at the face; and, in spite of possible variations in the resistances of different strata, or even given an insulating stratum, it is hard to see how a failure of the insulation could result in anything more serious than a blown fuse.

A. L. Rawlings.

London, S.W., *September 10th*, 1912.

Switchboard Fires.

I have been interested in the "Communicated" article on the above subject, published in your journal of September 6th. It is evident that the writer of the article has a wide knowledge and experience of his subject, but it surprises me that he does not refer to the totally ironclad and foolproof type of switchboard evolved during the last few years, which evidently has not come before his notice. The advent of the totally-enclosed ironclad foolproof switchboard has undoubtedly solved the problem of switchboard fires.

My company claim to be the absolute pioneers of the foolproof ironclad low and medium pressure switchboard, with thanks to the initiative of Mr. Frank Broadbent, probably the first consulting engineer to actively interest himself and assist in the development of this new phase of switchboard enterprise.

For the benefit of the writer of the article, and for other of your readers who may be interested, I should like to mention that the latest developments of "Ironsafe" switchboards are able to fill, without extravagant first cost, the following comprehensive and drastic specification:—

1. The whole switchgear is self-contained, and can be built up from standard units entirely of metal, mica only being used for insulation. No combustible material of any sort is utilised; slate, marble and porcelain are entirely eliminated.

2. The bus-bars and connections are totally encased in a separate steel chamber, and are accessible only from the front. No gangways or expanded metal sides are needed. The saving of space is considerable. Every fuse can be replaced without close proximity to any live parts, the interlocking nature of each separate unit rendering it impossible to replace a fuse unless the switch controlling the circuit has first been operated. No switch is allowed to carry current through its hinges, and the blades of every switch are removed when the current is cut off, to such a distance from the live terminals that they can be renewed without the possibility of contact.

3. When required, access can only be obtained to the bus-bar chamber after current has first been removed, the cover of the chamber being interlocked with the switch controlling the main current.

4. Where it is desirable to employ oil-break apparatus, the whole of the foregoing conditions can be employed, the apparatus designed for the purpose being foolproof, and so constructed that when the current is first cut off, the fuses can be safely examined, and the oil switches examined without the slightest inconvenience.

5. "Ironsafe" switchboards required for use in collieries can now be supplied of the "explosion-proof" type, and conforming to the requirements of the new Mining Regulations for use in places where dangerous gases may be present.

In conclusion, I would like particularly to emphasise the fact that for ordinary commercial purposes for use in factories, central stations, dockyards, and the like, the first cost of this apparatus is a trifle higher than the old-fashioned open-type switchboard, but it is indisputably the cheaper method in the long run. To quote the words of one of our foremost engineers, the "appearance of the 'Ironsafe' switchboard, as compared with the ornate and decadent slate or marble effigy is to the trained eye as a modern 'Dreadnought' to its early predecessor."

Hubert Berry.
Berry, Skinner & Co.

London, E.C., *September 17th*, 1912.

BREAKDOWNS AND LEGAL LIABILITY.

[From our legal contributor.]

The accident which caused Islington to be plunged in darkness last week calls attention once more to the question of legal responsibility for occurrences of this character. Who, if anyone, is liable? On referring to the Acts which deal with the supply of electricity for lighting purposes, it will be found that the possibility of accident has been specially provided for. The Electric Lighting Clauses Act, 1899, provides that whenever the undertakers make default in supplying energy in accordance with the terms of the Board of Trade regulations, they shall be liable to such penalties as are prescribed in the regulations in that behalf. These penalties may be recovered summarily. The effect of the clause which provides for them is to impose a duty on every electric lighting company to keep up a constant supply. But they are not to be held liable in every case of stoppage. Thus there is a proviso to the effect that the penalties to be inflicted on the undertakers must in no case exceed in the aggregate the sum of £50 in respect of any defaults not being wilful defaults on the part of the undertakers for any one day, and provided also that in no case shall any penalty be inflicted in respect of any default if the Court are of opinion that the default was caused by inevitable accident or *force majeure*, or was of so slight or unimportant a character as not materially to affect the value of the supply.

There are few cases on the subject of inevitable accident, but it may be presumed that a stoppage due to the negligence of one of the servants of the lighting authority would not come under this head. In the case of Sun Insurance Co. *v.* Dublin Corporation (December 9th, 1899), a cable which had been laid down proved to be defective, and the supply of electricity accordingly broke down. This failure was held to have been caused by inevitable accident. This case, however, does not completely establish the proposition that a burning out is an inevitable accident. It is presumed that the Court would make inquiry into the cause of the burn-out. Thus, if a company with a view to saving the expense of a new cable were to deliberately overload an old one, an accident arising from this cause could scarcely be looked upon as inevitable. Again, suppose that a large addition was made to a number of consumers so that the machinery at the generating station might occasionally be taxed to its utmost capacity, a breakdown arising from such a cause could hardly be regarded as inevitable.

Force majeure is a legal phase, which relates to the happening of something for which the company could not reasonably be held liable, *e.g.*, a flood, earthquake, or a subsidence sufficiently violent to break the cable.

As to a breakdown due to an increase in the number of consumers, there is only one case, and this throws a somewhat doubtful light on the subject. The case in question, Marylebone Vestry *v.* Metropolitan Electric Supply Co., was heard in January, 1900. The company were summoned for making default in the supply of energy to the workhouse and vestry offices on certain days. They admitted the default, but pleaded in extenuation that their inability was due to inevitable accident caused by a great demand for electricity which had exceeded all expectations. The case was adjourned for three months, and was not heard of again.

In Shaddock *v.* London Electric Supply Corporation, (May 8th, 1900), the keeper of a licensed house at Deptford summoned the London Electric Supply Corporation for failure to supply his premises. The default was admitted, but the defence was *force majeure*, it being contended that, the supply of electricity having become deficient owing to unavoidable causes, it became essential that some portion of the district of the company should be cut off, and that Deptford was selected as causing the least public inconvenience. The full penalty of 40s. was inflicted in each of the seven cases, with 20 guineas costs in the first case and 2s. costs in each of the others.

NEW ELECTRICAL DEVICES, FITTINGS AND PLANT.

Credenda Continuity Fittings.

The Credenda Conduits Co., of Chester Street, Aston, Birmingham, have now introduced a continuity grip nipple, by means of which ordinary plain tubing and fittings can be made electrically continuous at a small cost. This nipple is slightly tapered, milled

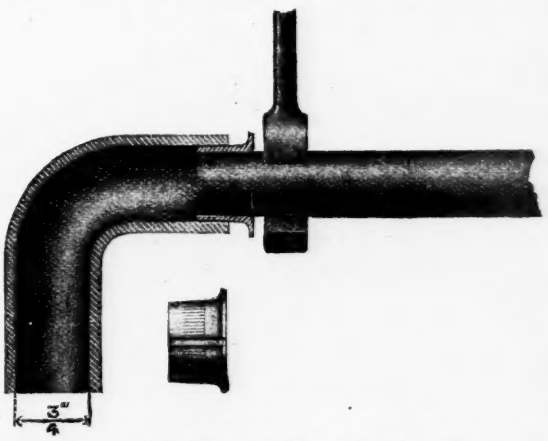


Fig. 1.—The Credenda Continuity Nipple.

on the outside, and split; it can be slipped over the tube end (from which the enamel must be removed) and driven into the fitting by means of a spanner (fig. 1), removing the interior enamel of the fitting itself in the process.

These nipples have a neat appearance when erected, and are stocked in ½ in. to 1 in. sizes.

Automatic Machine for Polishing Diamond Dies.

Our illustration, fig. 2, shows a new Poppe automatic machine for re-grinding diamond dies in which the draw-holes have become irregular or non-circular. The machine, which weighs about 130

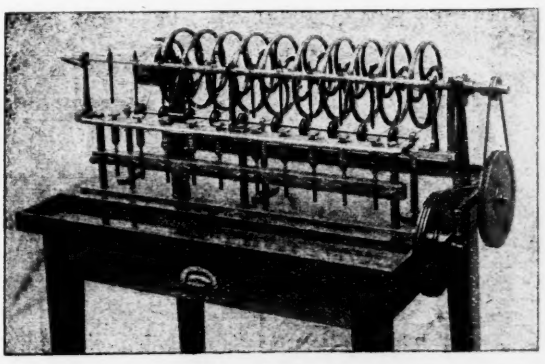


Fig. 2.—Poppe Automatic Grinder for Diamond Dies.

lb. and measures 26 in. × 38 in., is under th sole agency in this country of Messrs. Werths & Co., 41, Aldersgate Street, E.C.

One of its advantages over existing machines is that by the Poppe method one man can attend to 20 or 30 spindles polishing large and small calibres simultaneously, as against two or three

pindles in the ordinary way; the polishing is completed in the machine, no hand-finishing being required, and the consumption of diamond powder is small.

The fundamental feature of the Poppe method consists in the manner in which the grinding tool—a pointed steel pin—is manipulated about the axis of the rotating draw stone. The pin merely slips into the hole so far that its point rests freely on the walls of the drawing hole and grinds off the irregularities, moving under the action of its own weight. As the point scrapes over the interior of the hole, the polishing material is always conveyed to the place of grinding, which economises in the expensive diamond dust used.

It is further claimed that one man can easily attend to two or three Poppe machines polishing 20 to 30 stones simultaneously.

PROCEEDINGS OF INSTITUTIONS.

Power in Textile Mills.

At the Congress of the Textile Institute, on Friday last, an important discussion took place on this subject. The following introductory statement was made:—

Some time ago, at the suggestion of the Local Committee of the Institution of Electrical Engineers, a Joint Committee consisting of members of that body and of the Textile Institute was formed to investigate and report on the best methods of driving textile factories. Shortly after its formation it was for many reasons considered desirable that such a Committee, which had to report on what might be termed rival systems, should be elected independently of the great engineering institutions, and a decision was arrived at to confine the membership of the Committee to members of the Textile Institute itself. The work of this new Committee when fully formed will be to report periodically to the Council on the various methods of mill driving and on any improvements or developments that may be introduced either in this country or elsewhere, and it will be on this account a permanent Committee of the Institute.

The authors, when they consented to read these papers, did so on the understanding that they were to form merely a general introduction to the exhaustive and detailed treatment which this subject is subsequently to receive at the hands of this special Committee. It is obviously not possible in a single paper to treat in detail of the various matters connected with the drives advocated, though these are, of course, of distinct interest to the textile manufacturer, nor indeed were it possible would it be desirable to do so, since these details are afterwards to be made the subject of systematic investigation.

Prior to the writing of the papers the authors held several meetings, chiefly with a view to the adoption of a standard basis of estimating, so that any figures given in one paper might be readily comparable with corresponding figures in any other. They believe that the majority would prefer simple practical statements, and have agreed, so far as is possible, to adhere to these.

In endeavouring to arrive at a basis for expression of results, an important difficulty is at once obvious—namely, the adoption of a common power unit. The majority of manufacturers, using as they do reciprocating steam engines, think and speak in indicated horse-power. The indicator is applicable to the gas engine and the oil engine, as well as to the steam engine, and records with reasonable accuracy the work done on the piston. Unfortunately for comparative purposes, the net or useful power commonly called brake or shaft horse-power is not proportional to the indicated horse-power for any two engines. Again, with the indicator it is not practicable to ascertain the horse-power of a steam turbine. Still again, electrical power plays an important part in factory driving, and is destined to play a much larger part in the future. While electricity is purchased by the B. of T. unit, and electrical engineers think and talk in kilowatts, here, however, the difficulty is not so great, as the kilowatt and the brake or shaft horse-power bear a constant ratio to one another—viz., 1,000 to 746, and so are readily convertible. The authors have decided to adopt the brake horse-power as their standard. In good steam-engine practice the brake horse-power is to the indicated horse-power as 9 : 10, in good gas-engine practice as 8·5 : 10, and in Diesel oil-engine practice as 8 : 10. These ratios are arbitrarily adopted for the papers, but purchasers of prime movers or motors of any type can always obtain guarantees of mechanical efficiency from the makers, and, should these not correspond with the ratios given above, the conversion and adjustment is a simple one.

The following bases for running costs and charges have likewise been adopted for each paper:—

Running hours per annum: For the spinning mill or weaving shed, 2,750.

Interest and depreciation on engines, turbines, and electrical machinery, 10 per cent.

Interest and depreciation on boilers, gas plant, tank work, and the like, 10 per cent.

Interest and depreciation on buildings and foundations, 8 per cent.

Labour: Skilled engineers £120 per annum; mechanics and electricians, £100 per annum; labourers, firemen, &c., £65 per annum.

Fuel: Steam or bituminous producer coal, 11s. per ton; anthracite, 32s. per ton; coke, 13s. per ton; Diesel oil, 50s. per ton.

It is the authors' sincere wish that the papers will do something towards assisting textile manufacturers in deciding upon the most suitable procedure in each instance when new works are to be built or old ones extended or altered.

Mr. George B. Storie (Manchester) presented the case for the steam engine; he said that no country in the world produced finer engines than those found in the textile factories of Great Britain, but he questioned whether this high state of excellency was to be maintained. During the last three years competition of an unhealthy nature had been taking place, and firms of the highest standing, unable to withstand the financial strain, had been compelled to close their doors. He hoped the end of this ruinous practice of underselling was in sight.

The chief factors to be considered in selecting a prime mover for driving a textile mill were reliability, uniformity of speed and economy—especially reliability. He would endeavour to show that with steam engines or turbines these three requirements could be fulfilled, irrespective of the manner in which the power was conveyed to the machines in the factory.

The author then explained the supersession of the Corliss engine, formerly the standard type for mill driving, by the drop-valve type with superheated steam; one of the latter engines, belonging to the Durham Street Weaving Co., Belfast, with steam superheated to 700° F., was using only 8·7 lb. of steam per I.H.P.-hour. A drop-valve engine at York Road Mills, Belfast, working with saturated steam, consumed 11·9 lb. steam per I.H.P.-hour.

The steam turbine, he said, was likely to play a great part in the driving of textile mills in the future. As regarded reliability, about which there was some doubt when the earlier machines were installed, there was now no question, and the turbine ranked in service with the reciprocating engine. Evidence as to the confidence placed in its behaviour could be obtained at almost any large power station in this country, where comparatively few turbines could be seen doing the work once performed by a large number of reciprocating engines now standing idle.

In respect of uniformity of speed the turbine offered very great advantages, as, owing to its absolutely uniform turning movement, combined with great storage of kinetic energy in the revolving parts, the speed regulation could be accomplished in a more efficient manner than was possible with reciprocating engines.

The cost of oil was extremely low, about 1 per cent. of the cost of the fuel used, while for a reciprocating engine it would be about 8 per cent. In many cases the absence of oil in the exhaust steam resulted in a much greater saving than the cost of oil itself. Amongst other advantages were: Small number of moving parts, few repairs, small space required, and low first cost. The turbine must be recognised as the simplest heat engine of the present time.

Tests of a 1,000-KW. turbo-generator carried out in October last year showed, with steam at 162 lb. superheated to 667° F., and with an absolute pressure of 1·43 lb. in the exhaust pipe, a consumption of 11·55 lb. of steam per KW.-hour, and 8 lb. per B.H.P.-hour—the lowest steam consumpton recorded. Moreover, the turbine was capable of utilising the exhaust steam from existing engines and greatly enhancing the output, at small cost, with increased economy; a 750-I.H.P. engine thus combined with a 400-KW. turbo-generator gave a total output of 1,250 I.H.P., while the steam consumption was reduced from 15 or more to 11·4 lb. per I.H.P.-hour.

In works where the dyeing and finishing of textile materials was carried on and where comparatively large quantities of low-pressure steam were required for boiling and drying, turbine driving offered special advantages. In generating steam in dyeworks, a common practice was to install batteries of high and low-pressure boilers, the former supplying steam for power and the latter for manufacturing purposes. In some works high-pressure boilers only had been installed, and the steam reduced to the necessary low pressure by means of reducing valves. If in this arrangement the reducing valve was replaced by a back-pressure turbine in which the steam required for boiling and drying was allowed to expand to the desired low pressure, great economy could be effected, and, in addition to the plant being highly efficient, power for driving the works was available at a cost considerably less than it could be obtained at from any other source.

The buildings and foundations cost much less in the case of turbine plant than in that of the reciprocating engine, and the costs for labour, repairs, oil and stores were exceedingly low. It was not uncommon practice to judge the economy of an installation by the fuel or steam consumption. This, however, was not alone sufficient to allow of a true estimate being formed of its overall economy. It was imperative when a new plant was in contemplation that the steam user should take steps to ascertain how many other items had to be added to the cost of the fuel, in order to know how much the production of his power would cost, before he decided upon the prime mover that was to drive his mill.

The author appended to his paper tables showing the relative capital and running costs of various drives, and a list of the principal turbine plants installed and on order for driving British textile mills. According to the former, a 750-KW. turbo-electric plant complete cost £8,584, and the running cost (1,080 I.H.P.) was £2 4s. 4d. per I.H.P. per annum, inclusive, corresponding to 0·3d. per KW.-hour. A reciprocating engine electric plant of equal output would cost £10,684, and the running cost came to £2 10s. 8d. per I.H.P. per annum, equivalent to 0·34d. per unit. A reciprocating engine arranged for rope driving under similar conditions cost £9,434, and the running cost was £2 7s. 10½d. per I.H.P. per annum.

PRINCIPAL TURBINE PLANTS INSTALLED AND ON ORDER FOR DRIVING TEXTILE MILLS IN BRITAIN.

User.	Maker's name.	Type.	Loads in KW.	Steam pres. Lb. per sq. in.	Revolutions.	Current.	Voltage.
—	A.E.G. of Berlin	Horizontal Curtis	2,000	150	1,500	Alternating	500
—	,,	,,	1,000	170	3,000	,,	,,
—	,,	,,	1,000	170	3,000	,,	,,
—	,,	,,	1,000	170	3,000	,,	,,
Kearsley Spinning Co.	,,	,,	750	200	3,000	,,	550
,,	,,	,,	,,	,,	,,	,,	,,
—	,,	Impulse Curtis	1,000	100	,,	,,	3,000
—	,,	,,	,,	,,	,,	,,	,,
—	,,	,,	2,000	150	1,500	,,	525
Ark Mill, Ltd., Stockport	Fraser & Chalmers & Siemens	Rateau	600	160	3,000	,,	500
,,	,,	,,	,,	,,	,,	,,	,,
Ashton, Harrison and Co.	Willans & Robinson & Siemens	Willans-Parsons	1,000	200	1,500	,,	,,
Brown & Stewart, Dalmarnock	,,	Exhaust Parsons	375	16 abs.	2,700	Direct	250
Hollins, Peasley	,,	Willans-Parsons	375	150	3,000	Alternating	500
Clough, Keighley	,,	,,	375	160	3,000	,,	550
Thor Cotton Spinning Co.	,,	,,	500	160	3,000	,,	,,
,,	,,	,,	,,	,,	,,	,,	,,
James Scott and Sons, Dundee	Howden & Co. and Siemens	Impulse Zoelly	1,000 1,250	150	,,	,,	450
Mellor & Sons, Ashton-u-Lyne	Greenwood and Batley	Multiple Wheel De Laval	1,000	200	1,500	,,	,,
Falcon Mill, Ltd.	Musgrave & Sons, and Siemens	Zoelly	400	160	3,000	,,	,,
,,	,,	,,	,,	,,	,,	,,	,,
Braidwater Spinning Co.	B.T.H. Co.	Horizontal Curtis	750	150	,,	,,	,,
Tootal, Broadhurst, Lee Co.	,,	Curtis	1,500	157	,,	,,	550
Tootal, Broadhurst, Lee Co.	,,	Curtis	1,500	157	3,000	Alternating	350
English Sewing Cotton Co., Belper.	,,	,,	1,000	180	,,	,,	,,
Thos. Rhodes, Hollingworth.	,,	,,	750	170	,,	,,	440
English Sewing Cotton Co, Matlock.	,,	,,	350	180	,,	,,	550
Ashworth, Hadwin and Co.	Willans & Robinson & Dick, Kerr	Willans-Parsons	750	185	1,500	,,	440
Sladen Wood Mill Co.	Brush Electric Eng. Co.	Brush-Parsons	500	200	3,000	,,	500
—	,,	,,	535	160	3,000	,,	,,
—	,,	Brush disk and drum	1,550	200	,,	,,	,,
—	,,	,,	1,200	180	,,	,,	,,
Sladen Wood Mill Co.	,,	,,	750	200	,,	,,	,,
Milnrow Spinning Co., Ltd.	,,	,,	,,	155	,,	,,	400
—	,,	Exhaust Brush-Parsons	400	16 abs.	,,	,,	500
The Leather Cloth Co.	Willans & Robinson and General Electric Co.	Reducing disk and drum	500	95 abs.	3,000	,,	480
English Sewing Cotton Co., Skipton	Brit. West. Co.	Westinghouse-Parsons	1,000	170	,,	,,	550
Oldham Twist Spinning Co., Oldham	,,	Westinghouse-Rateau	820	160	,,	,,	440
Lister & Co., Bradford	,,	Mixed pressure Rateau	700	120 and 16 abs.	2,500	Direct	200
William Smeeton, Ltd., Halifax	,,	Westinghouse-Rateau	400	90	3,600	Alternating	440
R. H. Barker and Co., Wakefield	,,	,,	,,	160	,,	,,	,,
J. Haigh & Sons, Huddersfield	,,	,,	300	95	3,000	,,	,,

The steam temperature in most cases was 500-575° F., and the frequency 50 cycles per second, except in two cases.

MR. T. R. WOLLASTON, of Manchester, dealt with the subject of gas power. Considering *seriatim* the objections brought against gas engines, he claimed that they were now as easy to start as any steam engine, if not easier; there was no difficulty in maintaining a steady quality of gas if suction plant was not used; the overall cost of the plant was no greater than that of steam plant; the liability of gas plant to breakdown was steadily decreasing; the regularity of turning was amply sufficient; the space occupied might be greater, in the case of large powers, but the parts of the plant could be coupled together in many ways, so as to utilise waste space, and the distance between gas plant and engine was of no consequence; the reliability of gas plant, as witnessed by Mr. Hodgkinson, of the Hollins Mill, Marple, was unsurpassed by the great majority of steam installations, his engine having run on Mond gas for 21 months with only one running stop, lasting a few minutes. The author, while acknowledging that the suction gas plant had been largely instrumental in popularising gas power, expressed the view that it was responsible for at least one-half of the unsatisfactory installations of gas power plant in textile mills, owing to the lack of proper provision for correct regulation of the quality of the gas. He regarded electricity not as a competitor with gas, but as a means of transmission, and believed it to have a great future in the textile industries; everything he said in favour of gas power for mechanical driving in textile mills applied with added import to the generation of electrical energy at the mill or at the central station.

The fuel cost per B.H.P.-hour for the gas engine, as compared with that for a high-class steam engine, was in the ratio of about 5 : 9. Taking the gas engine fuel at 1¼ lb. of coal, and that of the Diesel engine at ½ lb. of oil per B.H.P.-hour, costing respectively 11s. and 50s. per ton, the fuel costs were as 14 : 25. Steam was always required in textile mills; about 2 lb. of steam per hour per H.P. driven could be obtained from boilers coupled to the exhaust of the gas engines, or probably about half the total required, and much of the balance could be got by burning the tar under the boiler. One ton of tar was produced by 25 tons of coal, and was equivalent to 1 ton of coal. The stand-by losses of gas engines were about one quarter those of the average boiler house, and careless stoking did not affect gas plant as it did steam plant.

One of the most important advantages of gas power for textile mills was the facility with which gas could be led any distance for heating purposes; of the total steam generated in bleaching, dyeing and print works, only one-third was used for power, the rest being employed for heating and boiling, with the result that enormous losses occurred through condensation in the pipes, which would be entirely obviated if gas were used.

Lastly, the by-products recovered from the gas plant were of great value, and the price of sulphate of ammonia, at present about £14 per ton, tended to rise. The probable adoption of gas recovery plant at central stations would decrease the cost of energy, and, when a firm had several mills close together, the system could be employed in a private plant. About 90 lb. of sulphate of ammonia could be obtained from a ton of coal, worth about 11s.—as much as the coal itself.

In appendices the author showed that the results of the Mond gas plant at Hollins Mill were as follows, after adjustment to the basis laid down in the introductory statement:—

Running cost	£1,080
Interest and depreciation on £7,250	725
Interest on buildings, £160	128
	£1,933
Sale of tar and sulphate of ammonia... ...	470
Net cost	£1,463

At 670 B.H.P. the cost per B.H.P-hour was 0·19d., and per KW.-hour 0·298d. The capital cost of a gas power installation of 250 B.H.P. would be £3,050. The net inclusive running cost would be £708, equivalent to 0·248d. per B.H.P.-hour.

For a large textile works with several departments, requiring 3,500 B.H.P., Mond gas recovery plant, gas engines and dynamos, &c., cost, complete, £49,000; the running costs would be £11,381, less sale of by-products £3,937, net cost £7,444. The cost per B.H.P.-hour would be 0·149d., and per unit 0·222d.

MR. FRANK CARTER, of Stockport, read a paper on the suitability of the Diesel engine for textile mill driving. Taking a weaving shed requiring 320 B.H.P., with oil at 50s. per ton, the capital cost (with rope drive) would be £3,565. The running cost, inclusive of capital charges, would be £913 per annum, equal to 0·33d. per B.H.P.-hour. For a spinning mill using 1,000 H.P., with rope drive, the capital cost would be £10,290; the running costs would be £2,699 per annum, equal to 0·26d. per B.H.P.-hour. The author, however, referred to the interest taken in electrical driving, and gave the figures for the same mills on this system. The plant for the weaving shed would cost £3,804, and the running cost would be £904, equivalent to 0·49d. per unit. The cost of the spinning mill installation would be £11,570, and the running cost would be £2,745 per annum, equivalent to 0·39d. per unit. After referring to the necessity of including in comparative statements the expenditure on all auxiliaries, cleaning and repairs, &c., the author pointed out that the Diesel engine was a self-contained plant, and that the fuel could be stored in a very small space and handled with ease, while there was no ash or clinker to be got rid of—often a difficult matter. Neither was there trouble from smoke or fumes. As regarded steady turning and reliability, the Diesel engine was equal to the most modern steam engine, and the supply of oil was abundant; recent fluctuations in price were due to the lack of sufficient oil-carrying vessels, but 66 of these were being built, and as soon as they were in service the price would become normal. The engine was economical, the fuel safe and cheap, preignition impossible, vaporisers and ignition devices were absent, the engine could be started easily, and was self-contained, compact and silent. A large number of Diesel engines had been installed in textile factories, especially in India, and the author gave a list of a score of installations with which he was personally acquainted. Figures obtained in electricity supply stations were also quoted showing that the total works cost with Diesel engines was about half that of steam and gas plant, for powers up to 1,000 H.P.

The subject of electrical power in textile mills was handled by MR. J. F. CROWLEY (Manchester), and we give his paper in abstract:—

A little over eight years ago "the actual horse-power of motors installed for driving textile factories in Great Britain was limited to a few hundreds, practically all in one mill." Four years later it had been increased to 28,000 H.P., and to-day the textile load of three power supply companies would practically total this figure, which is less than the advertised sales of textile motors of several of the larger electrical manufacturing companies.

Prior to January, 1911, considerably less than 300 motors in all had been supplied for the individual driving of looms in the United Kingdom. To-day over 7,000 of these have been supplied, or are on order, for loom driving, about one-half of these being supplied by a single company. The case for electrical driving must be a strong one to justify such general adoption. This case does not rest mainly on a saving in transmission losses. It rests broadly on—

(*a*) Steadiness of drive, resulting in higher maintained speeds, increased production, and improved quality of material.

(*b*) Specific advantages on the adoption of individual drive resulting in still greater production and improvement in quality.

The other advantages, such as flexibility, lighter and cheaper buildings, better utilisation of building space, concentration of generating plant, improved illumination, reduced risk of accident, &c., have been frequently referred to, and need not be touched on here.

It is very difficult to convince the average manufacturer that with the ordinary mechanical transmission, whether rope, gearing, line shaft or belting, or a combination of these, serious fluctuations in speed occur, and that when they occur they affect production and quality to any marked extent.

Delicate instruments have, however, been constructed for recording speed variations, and interesting and important work in this connection has been carried out in Yorkshire mills by Mr. W. B. Woodhouse.

The mule is the worst offender in the textile mill so far as speed fluctuations are concerned, as the following tachograph readings, taken by Mr. Woodhouse, will show :—

Mule counter shaft.	*Max. speed range.*
Mechanical drive	25 % of mean speed.
Individual electrical motor drive D.C.	17 % " "
Individual electrical motor drive A.C.	6 % " "

The power curve of a mule is a peculiar one, the load showing peaks which may be many times the average, falling away during a portion of the cycle to a value much below the average. Ordinarily the mule load in a mechanically-operated mill affects the running of every machine in any way connected with the shafting from which the mules are operated, and this is actually a principle in the laying out of spinning mills. The momentum of the engine and of all shafting, &c., connecting the mules to the engine is depended upon to steady the drive of the mules themselves, and since, of course, no energy can be given to or taken from a revolving mass without altering its speed, we have here a fruitful source of trouble. On electrical drive, mules may either be group or individually driven. Important principles to be borne in mind are that, as far as possible, constant speed should be maintained during the "draw" or the actual spinning portion of the mule cycle, and that a given variation in speed where mules are grouped for mechanical drive or electrical drive is liable to be far more serious than a variation of similar range with individually driven mules. With individual drive, the speed fluctuations would naturally result from the variation in load of the mule itself, and would therefore follow the cycle of operations of the mule.

It is generally agreed that the motors should have a good efficiency over a particularly wide range of load and a high overload capacity. The best results have been obtained on worsted mules, since the problem is here somewhat simpler and the motors required of smaller size.

In general, it may be said that group electrical driving is better than mechanical driving, particularly from the point of view of the mill as a whole, and that individually driven mules give an increased production of about 5 per cent. over group or mechanically driven machines, even when the very simple expedient of merely belting an ordinary three-phase motor of suitable size and of good regulation direct to the mule countershaft is adopted. A considerable saving in power is one of the special features of the individual drive.

For the driving of ring-spinning frames electricity has peculiar advantages, and motors of the single-phase commutator and the three-phase commutator type have been developed for this purpose. Owing to well-known peculiarities, with a ring frame driven at constant speed the yarn is subjected to varying tension, and as the speed at which the frame can be run is determined by the maximum tension the yarn will stand, the speed must be such as to prevent this tension being exceeded at any moment, and consequently with a constant-speed drive considerable loss in production occurs. The only satisfactory solution, so far, has been the electrical one, which gives not only a low speed during the forming of the base of the cop, but also an automatic variation of the speed during the cyclic movement of the ring rail.

The question of ring spinning *v.* mule spinning in the worsted trade is one of considerable importance, and there is little doubt that the case for the ring frame is very largely aided by the advantages which individual electrical driving with automatic speed control can give. Tests were carried out in a German worsted mill on a spinning frame of 400 spindles, rings 1·9 in. diameter, spindle space 2¾ in. Tests carried out on 16 frames driven from an electrically-operated line shaft, with therefore a much steadier turning movement than would be provided by the ordinary mechanical drive, showed that the average number of broken ends per frame during a period of 10 minutes was 5·5, and that the average time taken to complete a cop was 2 hours 47 minutes. On conversion to individual drive and the adjustment of the automatic regulator, so that the average number of broken ends did not exceed the figure given above, it was found that the average time taken to complete a cop was 2 hours 17 minutes, and that in no case did the time exceed 2 hours 22 minutes. This clearly showed that by the use of individual drive with an automatic regulator a saving in time of 30 minutes per doffing, or 18 per cent., was obtained. It may be added that with group electrical drive the spindle speed was 5,500 R.P.M., while with individual drive after the first eight minutes of the run the maximum average speed was 6,900 R.P.M. Similar tests in a Lancashire cotton mill resulted in an increased production of about 15 per cent. This result also was obtained against group electrical driving, and both results show that in the case of ring spinning frames greater increases in production may be obtained by the adoption of individual drive with automatic regulation than in the case of loom driving. When this fact is fully realised, a similar development to that which obtains in the application of individual driving to weaving sheds may confidently be expected in spinning mills.

The following tests were carried out on a ring doubling frame now on the mains of the Lancashire Electric Power Co., before and after conversion to individual driving :—

	Max. speed range.
Mechanical drive	6 % of mean speed.
Individual electrical motor drive ...	0·5 % " "

This shows clearly the advantages of the individual drive, and it may be said generally that constant-speed motors are usually employed for the electrical driving of these machines.

The speeds at which mechanically-driven looms can be run can be increased by group electrical driving, and to a still greater extent by individual electrical driving; the load factor can be improved to a certain extent by group driving, owing to the steadier speeds causing fewer breakages, and to a remarkable extent by individual driving, owing to the prompter starts obtainable.

The following test results, which are self-explanatory, are instructive, and illustrate the first part of the case for electrical driving, so far as weaving sheds are concerned :—

	Max. speed range.
1. Engine	5·5 % of mean speed.
Loom line shaft (near belt drive) ...	9 % " "
" " (middle)	12 % " "
" " (end)	16·5 % " "
2. Loom line shaft (group electrical drive)	6 % " "
3. Loom (individual electrical drive) ...	2 % " "

Perhaps the principal lesson to be gathered from these figures is the steady manner in which the speed fluctuations grow worse as the distance from the engine increases, and this is confirmed by other tests. In a Yorkshire mill it was shown that for a 3 per cent. variation in engine speed, 20 per cent. variation occurred on the line shafting. In a high-class Lancashire mill, for a variation in speed of 5 per cent. on the engine shaft, the line shaft speed varied 16 per cent.

The question of load factor is also of great importance. The following results relate to a test carried out in a spinning mill on jute looms, to convince the manufacturer of the results it was possible to obtain before individual driving had attained the position it holds to-day. The looms were changed from the ordinary mechanical drive to individual motor-gear drive, and it was found that the average speeds could be raised 9 per cent. without any increase in breakages, the material being improved in quality, and the production increased by from 15 to 20 per cent. The excess of the increase in production over the increase in speed was due to the improved load factor. The test was carried out by an independent authority on behalf of the manufacturer.

To obtain the increased production claimed for individual electrical driving the power taken by the loom has naturally to be increased, and this increase usually takes place as the square of the speed. The proportion the power costs in any textile factory bear to the total running costs is, however, very small, being stated in the case of woollen mills to be from 2 to 5 per cent. of the total costs, and consequently the power increase referred to will have little effect on the actual cost of the product. For Lancashire mills I was able to show, assuming figures based on the Board of Trade returns to hold true for an individual case, that a 10 per cent. increase in production actually resulted in a 30 per cent. increase in profits after full allowance had been made for the increase in power costs referred to.

The question of temperature rise as affected by the use of electrical motors has been brought into prominence in Lancashire recently.

The total loss in a ½-H.P. loom motor on full load is only 15 per cent., and with the slight electrical losses in the cabling, and the loss in the belt or gear, the total is lower than in any mechanically-driven shed. It must be borne in mind that with electrical transmission, as distinct from mechanical transmission, some 20 to 30 per cent. of the total transmission loss takes place in the engine-room itself.

The transmission losses in the case of the average mechanical drive in a weaving shed are undoubtedly greater than in a high-class modern individual equipment, and therefore the temperature rise due to these losses must obviously be greater also.

Motors for the individual driving of mules are almost invariably three-phase, the unsuitability of the direct-current motor being well shown by the speed fluctuation of a mule driven by such a motor. Motors for driving ring-spinning and doubling machines may be either three-phase, single-phase or direct-current, but the two former are the more suitable; of the variable-speed type for ring spinning, and the constant-speed type for ring doubling. For looms, three-phase or occasionally two-phase motors are used. The manufacturer will then install three-phase generators of standard voltage and standard frequency. For the driving of printing machinery direct-current motors, owing to their adaptability to large variations in speed, are specially suitable. Three-phase and single-phase commutator motors and motors of the pole-changing type are also used for this purpose. A voltage of 500 volts and a frequency of 50 periods are now common in the textile districts, but several large power supply companies standardise on 400 volts, as this leaves single-phase current at 230 volts available for lighting. For a weaving shed a voltage of 200 is suitable, since

the building of small motors for a higher voltage means a somewhat lowered efficiency and increased manufacturing cost. The following figures are given as a rough guide to capital expenditure :—

		Turbo-Alternators (3,000 r.p.m., 50 Cycles).			Reciprocating Sets.			
K.W.	Volts.	Alternator efficiency. Per cent.	Alternator without bearings.	Turbine and bed-plate, &c.	Speed, R.P.M.	Alternator efficiency. Per cent.	Alternator and exciter.	Condensing plant and engine.
250	220/3,000	85	£700	£904	375	92	£440	£820
500	440/6,600	90	850	1,322	300	92	800	2,200
1,000	,,	92·5	1,050	2,200	220	93	1,500	5,000
1,500	,,	93	1,350	2,800	230	94	1,650	7,850
2,000	,,	93·5	1,650	3,200	—	—	—	—

Turbo-alternators are finding increasing favour for textile driving, and their use is every day extending.

When supply is taken from a public supply company, transformers replace the generators, and are almost invariably supplied by the power companies and under the direction of their engineers.

Breakdowns very seldom occur on transformers, and the question of stand-by is usually met by the power supply company concerned standardising their transformers and keeping spares ready to hand for insertion if required.

The subject of switchgear is rather a technical one, and it is usually best to leave the main details in the hands of a good consulting engineer or a reliable manufacturing company.

In order that power consumption figures may readily be taken, special provision should be made for the insertion of instruments in the various circuits controlled without interfering with the running of particular machines. In a large individual drive equipment for a weaving shed recently designed, this has been reduced to such refinement that, without stopping a single loom, power readings on each motor can at any time be taken, and similar figures obtained on each main feeder line supplying a row of looms.

Very special consideration is required in the designing of the motors for textile work, and considerable experience in this class of work has been necessary for the evolution of the best prevailing types. The following summarised requirements may be given :—

1. Satisfactory protection from dust and "fly."
2. Liberal rating, as the load is usually continuous, the working conditions stringent, and factory temperatures high.
3. High efficiency for large load variations.
4. High starting torque, that for loom motors usually being two and a half times and for spinning machines twice normal torque.
5. Small variation in speed from no load to full load.
6. Good regulation or small variation in speed for a given variation in voltage.
7. Dimensions of such a nature as to meet the prevailing factory conditions.
8. Bearings designed to be absolutely "fly" proof.

It has been a rather remarkable feature of electrical work during recent years that practically every new development has originated and has been carried out in the electrical factory, and in consequence of this it is generally found that the larger electrical manufacturer possesses the best available knowledge of the type of material to put forward for each individual case, and that it is to a large extent advisable, where a reliable consulting engineer has not been called in, and when matters of cost have been finally settled, to leave all plant details in the hands of a manufacturing concern with experience in the class of work required, demanding from them guarantees as to performance and tests to show that the guarantees given are adhered to.

In deciding whether to take power from an outside supply company a number of factors have to be taken into consideration, and it is always desirable when in the area of such a company to obtain electrical rates from them for comparison with the estimated cost of private generation before deciding on the course to adopt. In the most competitive areas, where the demand is high and better opportunities exist for the power company, 0·5d. per unit is regarded to-day as a good competitive figure for a fair load on the usual cotton mill load factor of 25 per cent. to 29 per cent. For particularly good loads from the station engineer's standpoint, figures of 0·45d. and 0·4d. per unit are quoted, and in one area some manufacturers actually obtain current at 0·3d. per unit. But this figure must be regarded as rather special, and the remarks made about 0·5d. per unit taken exactly as given. The price at which it pays to take current from outside depends altogether on the individual case, and current at 0·6d. and 0·75d. and even higher may very well pay the manufacturer in particular cases.

The system of supply on restricted demand is in force with some supply companies, and manufacturers with existing plant may find it an advantage to drive, say, preparing rooms with current at a low rate on this basis, the understanding being that the supply is cut off at a definite hour during a certain period of the year.

A strong point in favour of power supply companies is that as their load increases their running costs must be reduced, a fact that is borne out by the steady reduction they have been able to effect in their rates, and that in time advantages from the point of view of economical working should enable them to produce current at rates considerably below those possible with the best private plants on mill load.

If the course suggested of comparing the power companies' rate with the cost of private generation is carried out, it will be practical before making the comparison to add to the latter costs a fair percentage to cover advantages such as reduced capital expenditure, freedom from worry about engineering details, ease of running any part of the mill by itself, &c.

The discussion on the papers, which took place after the whole series had been presented, gave evidence of the enormous amount of interest taken in the subject by those engaged in the various branches of the textile industries. In the extent of its appeal, the series of papers stands out as the most important which has yet been submitted to the members of the Institute, and as time goes on the interest aroused in the subject will, without doubt, be considerably increased by the issue of the reports of the Special Committee of the Institute, which has the whole matter of the driving of textile mills under consideration.

A somewhat curious fact was that so far as the electric drive was concerned no one paid any attention to the material saving in mill construction and the advantage of increased light, and so forth. These aspects of the case have been pressed forward on other occasions before manufacturers and mill managers, and it is quite possible, of course, that there is general recognition of the advantages of the electric drive in regard to these phases of the subject. The various other methods of driving advocated—steam, gas and oil—were strongly criticised upon many of their suggested advantages, and when the discussion was of necessity brought to a close owing to inability to devote further time to the matter, it was probably true, as one delegate put it, that those present knew just about as much at the end as they did before the papers were read. It was unfortunate in every way that such an intricate, complex and debatable question should be brought forward at the closing session of the Congress.

The criticisms of the various methods had by no means been exhausted when the closure was applied, and, the authors not having time to reply, it was decided that further questions might be forwarded to the Institute within the next 14 days, and replies would then be made to the whole of the questions raised. The discussion will certainly stimulate the permanent Mill Driving Committee of the Textile Institute to go deeply into the matter in order that fuller information may be placed at the disposal of the members of the Institute.

Lord Rotherham, the president of the Institute, said that the papers were of a very important character, and he thought everyone would recognise the importance of hearing all sides of the question upon such an intricate matter, in order to be in a position to arrive at an accurate opinion as to which was the best, the most efficient and the most economical drive for textile factories nowadays. It was obviously most important that manufacturers should keep themselves posted as to new methods and new inventions, and in that way keep themselves abreast of the most intelligent and enterprising of their competitors whether at home or abroad.

Mr. A. N. Wrye (Guernsey) said that from the sizes of the installations mentioned in the various papers, it was evident that they were designed more for the requirements of large mills in Lancashire and Yorkshire than for the much smaller requirements of mills in the Border district, where costs were relatively higher per unit. In nearly all cases it was admitted that electrical transmission had great advantages, and it was reasonable to suppose that, whatever the prime mover might be, electrical transmission would be even more largely used than it was at the present day. For various reasons it was probably economical and advisable, in some cases, to use isolated plant, but the price of electricity was falling, and as time went on, the position of the private plant would become more and more difficult. In the Hawick district it was frequently necessary to run the spinning plant all night, and with a large prime mover running at something under half load, the very good efficiency usually shown by the private plant would fall away completely.

Mr. Ram Singh said that, as a cotton manufacturer, he thought the steam drive was cheaper than the electric drive. Giving a shed 1,000 looms, the capital expenditure on individual electric driving would be £10 per loom. For looms driven by the best transmission, as he called it, it would be £3 to £3 10s., but he would take it at £4. Mr. Crowley had said there was a 10 per cent. increased production (in instances quoted) by the individual electric drive. For that 10 per cent. increase of production they had to pay £6,000 more—the difference between the cost of the systems. That was to say that the production would be equal to that of 1,100 looms. Taking the cost of the looms at £40 for driving by transmission, that figure including building, engine, boilers, chimney and everything, they could get 150 more looms with the £6,000 already mentioned, or an increased production of 15 per cent. It might be said that with the individual electric drive they reduced the pillars inside the sheds. In that case they would require stronger beams, and he had no hesitation in declaring that there would be no difference in the cost of mill construction.

Mr. Leon Gaster (London) strongly urged manufacturers to consult experts whenever they were in doubt on such difficult problems as those connected with the driving of textile mills.

Mr. H. Joseph (Hawick) said that the very low prices given by the speakers for fuel consumption and for cost of electricity were lower than could be got in his locality. There had been many remarks about speed regulation with electric driving, and whilst he would not go into the relative merits of the three-phase or continuous-current motor, he might say that their system in Hawick so far had been the group drive. Some excellent curves had been taken on steam drives and gas drives—there were none of the latter left in the town now—and the electric drive which succeeded both of

them, and the contrast between their speed regulation was exceedingly remarkable. Certainly it had been found that one of the great advantages of electric driving had been steadiness of speed

Mr. Oscar S. Hall (Bury), a large loom maker, said he did not think anybody was consulted more than he was as to the relative merits of systems of driving textile machinery. When he was asked if the best method of driving looms and textile machinery generally was by electric motors, his invariable reply was that it depended upon the circumstances of the case. The subject was far greater than many people thought it was. Electric motors were much more efficient the more complicated the weaving became. What he meant by that was that complicated Jacquard looms or other heavy and intricate machines were often kept standing for a while, and in cases like that there was no shafting running round, there was no wear and tear, and there were no losses, if they were run by the system referred to. Many other classes of looms and various types of textile machines were not kept continuously running because the manufacturers were not able to keep them fully occupied, and in all such cases driving by electricity had many advantages over other methods of driving.

BUSINESS NOTES.

Electric Lamp Patents Litigation.—From an announcement appearing in our advertisement pages to-day, it will be observed that the appeal of the "Z" Electric Lamp Manufacturing Co., Ltd., from the judgment of Mr. Justice Warrington upholding the validity of the master patent No. 23,899/04 of the Osram Lamps Works, Ltd., having been withdrawn, it is intended to enforce rights against all infringers. The "Z" Co. and the Foster Engineering Co., Ltd., have both been granted licences to manufacture and sell lamps under the above patent.

Lea Recorders.—Amongst the orders for their apparatus recently received by the "Lea" Recorder Co. are the following for electricity works:—Sunderland, Walthamstow (repeat order), Nuneaton, Kirkcaldy, Aberdeen (repeat order), and Croydon, as well as the Hobart Gas Co., Tasmania, the Ceara Tramways Co., and Ensenada Electricity Works, Cape Town Electricity Works, and Edmonton Electricity Works, Canada.

Miners' Safety Lamps.—We are informed that in the recent competition the winning lamp, and three of those to which £50 awards were given, were all fitted with Osram lamps. Many of these winning miners' lamps to which Osrams were fitted had been in actual service. The particular type of Osram lamp used in them is a 1·5-c.p., 2-volt lamp, and costs only ½d. per shift of approximately 12 hours.

Bankruptcy Proceedings. — Henry Hallifield Oxley (otherwise known as Oliver Huxley), 22, Uxbridge Road, Hanwell, Middlesex, consulting engineer.—The adjourned meeting of creditors in this case was held on Monday at the offices of the Official Receiver, 14, Bedford Row, W.C. The debtor's statement of affairs showed unsecured liabilities £1,424, and assets £117, or a deficiency of £1,307. It will be remembered that the debtor attributed his failure to want of employment, and losses owing to the attempted flotation of a company. His deficiency account showed that he had lost £1,400 by bad debts, and he had also incurred liabilities of £545 on behalf of a company. The previous meeting had been adjourned at the debtor's urgent request to enable him to complete negotiations with his friends which would enable him to bring in a scheme of arrangement for a composition. At the meeting on Monday the debtor did not attend. The Official Receiver reported that no proposal for a composition or scheme had been lodged, and that there was no explanation why this had not been done in the face of the statement made at the previous meeting. There was not a quorum of creditors present, so that no resolutions could be passed, and the matter remained in the hands of the Official Receiver, the chairman intimating that he would apply to the Court for an order of adjudication in bankruptcy.

Albert Edward Martin (Midland Electrical Supply Co.), electrical engineer, 39, Great Charles Street, Birmingham.—Receiving order made on September 9th on a creditor's petition. First meeting, September 25th; public examination, October 9th; both at Birmingham.

Westinghouse London Showroom.—In the accompanying picture we show a view of the new supplies showroom of the British Westinghouse Electric and Manufacturing Co., Ltd., at 179, Wardour Street, London, W.C. This, together with offices and stores on the same premises, has been established for the convenience of contractors and the trade. Clients can be taken there for the selection of their requirements, and moderate-sized trade orders can be executed from stock, larger ones being handled from the headquarters at Trafford Park, Manchester. We paid a visit to the premises early in the week and found a varied supply of Westinghouse electric supplies on view, including the following:—Westinghouse Auriga lamps from 8 to 1,000 c.p., Cooper-Hewitt mercury vapour lamps, single carbon flame arc lamps such as the company is to supply under the 12 months' contract for the Hammersmith Borough Council, and the Magazine flame lamp for 105 of which an order has been received from the S.E. and C. Railway, for their Ashford Works; a full line of tumbler switches, ironclad switchgear, distribution boards, wood blocks; also radiators (luminous, convector and Bastian types), and electric heating and cooking apparatus. A special feature is made of electric fans. These are supplied in many varieties. A large powerful ceiling fan is in position in the showroom, and this is a line which is chiefly supplied for export to India and other like countries. Fitted into the window there are box-blade fans suitable for picture theatre and general purposes. A Holophane demonstration cabinet will serve a very useful end, and a number of

Westinghouse Supplies Showroom.

excellent examples of fittings in this style are on view. One cannot exhaust in these notes all the lines of table standards and other fittings, silk shades and other lighting accessories that are displayed in a comparatively small space, but we have said sufficient to indicate the nature of the exhibit. It is intended very shortly to hold a stock of the Auriga drawn wire lamp. It is anticipated that a considerable over-the-counter trade will be done in many of the items enumerated. The main London Westinghouse establishment will, of course, remain at Norfolk Street, the Wardour Street premises being intended as a London office and store for the sale of Westinghouse electric supplies, many of which are already being manufactured at Trafford Park.

Book Notices.—"How to Take Out Patents." By A. E. Edwards. London: Arthur Edwards & Co., Ltd. Price 2s. net.

"Electricity." By Gisbert Kapp (Home University Library of Modern Knowledge). London: Williams & Norgate. Price 1s. net.

"Ignition of Gas by Miniature Electric Lamps with Tungsten Filaments." By H. H. Clark. "Magazines and Thaw Houses for Explosives." By C. Hall and S. P. Howell. "The Effect of Stemming on the Efficiency of Explosives." By W. O. Snelling and C. Hall. "The Transmission of Heat into Steam Boilers." By H. Kreisinger and W. T. Ray. 1912. Washington: Government Printing Office.

"*Journal* of the Franklin Institute." Vol. CLXXIV, No. 3. September, 1912. Philadelphia, Pa.: The Institute. Price 50 cents.

"Electricity for Everybody." By R. Borlase Matthews. 1912. London: Electrical Press, Ltd. Second Edition. Price 5s. net.

"Atti della Associazione Elettrotecnica Italiana." August, 1912. Milan: Stucchi, Ceretti & Co.

"Bulletin Mensuel de la Société Belge d'Electriciens." Vol. XXIX, Nos. 6 and 7. June and July, 1912. Brussels: E. Bruylant. Price 1 fr. 75.

"*Journal* of the American Society of Mechanical Engineers." September, 1912. New York: The Society. Price 35 cents.

"The Motor Manual." Fifteenth Edition. London: Temple Press, Ltd. Price 1s. 6d. net.

"History of the Monument to Commemorate the Sending of the First Train Order by Telegraph." New York: *Telegraph and Telephone Age.*

"Canada for the Investor and the Industrious Millions of Great Britain." By T. W. Sheffield. Bristol: J. W. Arrowsmith, Ltd. 1s. net.

"Wireless Telegraphy and How to Make the Apparatus." 1912. London: Cassell & Co., Ltd. Price 1s. net.

Catalogues and Lists.—Albion Metal Manufacturing Co., 68, Victoria Street, London, S.W.—Leaflet relating to their metal name-plates and advertisement souvenirs.

The Electrical Co., Ltd., 122-4, Charing Cross Road, London, W.C.—40-page list, giving illustrated descriptive matter, also tabulated information, prices, &c., of their direct-current motors and dynamos (110, 220, 440 and 500-volt machines), also motor-generators. Prices of spares and starters, instructions for starting and running machines, diagrams of connections, and full dimensional particulars are also published.

The London Electrical Trading Co., Ltd., Palmerston House, Old Broad Street, London, E.C., have prepared a specially-designed envelope for the purpose of advertising the Bastian "Pygmy" heater, and they will be glad to hear from contractors desiring to have a supply over-printed with their name and address.

The Union Electric Co., Ltd., Park Street, Southwark, London, S.E.—New 16-page booklet, entitled "The Attraction of Custom." It is intended to appeal to the actual user of light, and therefore is available for distribution by contractors. It compares flame arc lamps with high-pressure gas, and particularly brings out the merits of the "Excello," a number of excellent prints being included to illustrate the use of these in lighting the exteriors of a number of important London buildings. Copies can be obtained on application.

The Linolite Co., 25, Victoria Street, Westminster, S.W.—Price list of Woodhouse patent steel casing and accessories, of which they are the sole manufacturers.

South Africa.—According to the *British and South African Export Gazette*, additional plant is required for the Queen's Mine (Willoughby's Consolidated), and will include either a further 10 stamps or a complete 20-stamp battery; probably, also, a new sands treatment plant and a complete electrical power plant.

Trade Announcements.—The Westinghouse Cooper Hewitt Co., Ltd., of 151/2, Great Saffron Hill, London, E.C., inform us that they have appointed Mr. F. J. Lyons-Davis, of 27, Ruthin Gardens, Cardiff, as their agent in the South Wales district. Mr. Lyons-Davis will deal with this company's well-known specialities, namely, silica and Cooper-Hewitt lamps and mercury vapour converters.

On Monday next the Titan Lift Co., Ltd., are moving to new premises at 9/11, Eagle Street, Holborn, W.C. This is on account of the large increase in their business during the last two years. The new premises are provided with a "Titan" electric lift.

The General Electric Co., Ltd., are just now offering to the trade a quantity of electrical goods—stock rendered obsolete by the issuance of their complete catalogue—at greatly reduced prices. These are on view in a separate department at 67, Queen Victoria Street, E.C.

The British L.M. Ericsson Manufacturing Co., of London and Beeston, have appointed Messrs. Watson & Whyte, of 19, Waterloo Street, Glasgow, to be agents in Scotland for the sale of their telephone apparatus.

According to an Indian exchange, the Eastern Electric and Trading Co. announces that its head office is now removed from Sukkur to Karachi.

The Naylor (Patent) Battery Co., Ltd., of 1A, Lammermoor Road, Balham, London, S.W., inform us that they have taken over, for the purposes of extension, the business carried on by the Regenerating Battery Co., of 3A, Blenheim Street, Chelsea, London, S.W. All correspondence should in future be addressed to the new company as above.

Mr. Joseph West Howarth has, owing to the retirement of Mr. Harry Howarth, taken over the business of Messrs. Joseph Howarth & Co., lighting engineers, of 365, Rochdale Road, Manchester.

The Linolite Co. have taken over from the Woodhouse Steel Casing Co., Ltd., the sole rights to manufacture and sell steel casing, and fittings for the same, under their patents of 1906, 1909 and 1911, and are making arrangements to supply large or small quantities.

The South London Conduit Fittings Co., of 56A, Harleyford Road, Kennington, S.E., inform us that they are now manufacturing fittings for electrical conduits, and would be glad to receive inquiries.

For Sale.—The York City Electricity Department has for sale three electric capstans. The Halifax Tramways and Electricity Committee has for disposal a 750-kw. direct-coupled Belliss engine and E.C.C. dynamo, with surface condenser. See our advertisement pages to-day.

Two Continental Exhibitions.—With reference to the Barcelona and Ghent Exhibitions mentioned in our leaderette pages, inquiries respecting the former should be addressed to Anglo-International Permanent Exhibitions, Ltd., 76, Finsbury Pavement, London, E.C., the Commissioners-Delegate for the United Kingdom; those relating to the Ghent Exhibition should be sent to the office of the British Representative, 1, Southampton Row, London, W.C.

Canada.—Messrs. Ashmore, Benson, Pease & Co., Ltd., of Stockton-on-Tees, have been given an order by the Montreal Light, Heat and Power Co. to supply and erect at their Outremont station a four-lift gasholder of 3,000,000 cb. ft. capacity and a steel tank to contain the same. It is expected that the work will be begun immediately. The Canadian British Engineering Co., Ltd., are the Canadian representatives of Messrs. Ashmore, Benson, Pease and Co.

The "Magic" Suction Cleaner.—The stand of Messrs. Magic Appliances, Ltd., at the Hardware Exhibition at Olympia, faced the main entrance, and the cleaner was demonstrated in an interesting fashion throughout the day, by a stalwart white-clad negro, who cleaned rugs and furniture with great ease. Our readers are already fully familiar with the principle and construction of this electrically-operated cleaner.

LIGHTING and POWER NOTES.

Argentina.—It is reported from Tucuman that the Hydro-Electric Co. will commence its service on September 15th, giving current in 30 squares.

The Municipality of San Vicente (Buenos Ayres) has applied for permission to call for tenders for a public and private electric light station.—*Review of the River Plate.*

Australia.—The Port Melbourne (V.) Council has appointed Mr. Ashman as consulting engineer in connection with the proposed electric supply system, for which tenders are to be called shortly.

The North Sydney Council has advertised for applications for the concession to establish an electricity supply and for refuse destruction, also for competent electrical engineers to advise on and supervise the work of construction, &c.

Balderton.—An inquiry was held on September 12th by Mr. T. C. Ekin into the application of the Parish Council for a loan of £650 for street lighting by electricity, for which current will be supplied at 1d. per unit by Messrs. Simpson & Co. The only opposition was from one or two ratepayers who preferred gas lighting.

Basingstoke.—After considering a letter from the L. and S.W. Railway Co., in which the latter inquired whether the T.C. had any idea of establishing electricity works, as otherwise it would have to make alterations in its present plant, the Lighting Committee reported that it was not able to recommend the Council to apply for a prov. order. Having, however, given full consideration to an offer made by Messrs. Edwards & Armstrong to establish an electrical undertaking in the borough for the purpose of the public supply of electricity, it recommended the Council to render that firm all necessary facilities in connection with the matter.

Batley.—In reference to the controversy as to whether the local electricity works should be extended at a cost of about £20,000, or electric current obtained from the Yorkshire Power Co., it has been decided by the Electricity Committee to call in an independent adviser in regard to the matter.

Brazil.—The town of Santa Barbara, San Paulo, is having an electric lighting system installed under the supervision of a well-known German electrical engineer.

Burton-on-Trent.—The T.C. has decided to extend the low-tension overhead lines to supply the premises of the English Grain Co. An extension is also to be made to the Outwoods districts.

Clacton-on-Sea.—Mr. H. R. Hooper, on September 10th, held an inquiry into the application of the U.D.C. for a loan of £2,650 for mains, &c. The Inspector altered the particulars to £700 for services and £1,900 for mains. There was no opposition.

Continental Notes.—France.—Since 1911, according to an official report, electrical installations in the Department of the Aisne have undergone a remarkable multiplication. This is owing principally to the introduction of the high-pressure mains of the Compagnie Electrique du Nord. Some 34 subsidiary companies have been formed, drawing their supplies from this company, to work one or more communes, the length of the lines aggregating 124 km. Over 23 distribution systems are now either projected, under construction, or ready for working.

La Société Lorraine d'Electricité, of Nancy, has secured the concession for the supply of electrical energy for lighting and power purposes in a number of villages in the Departments of Vosges and Meurthe-et-Moselle.

Spain.—The municipal authorities of Palafragell (province of Gerona) have just invited tenders for the concession for the supply of electric energy for lighting and power purposes in the town during a period of 20 years.

Italy.—We are informed, says *La Revue Pratique de l'Electricité*, that a group of capitalists associated with concessionaires of sundry lignite mines in Italy have decided to establish, near Figline, a large sulphate of ammonia factory, utilising the excess of gas for a power station for the production and distribution of electric current.

Germany.—According to the *Deutsche Forstzeitung*, it is intended to set up a new power station on the great peat moor of Burtanger, and a second in the Stade neighbourhood near Bremervörde. By means of these two stations a large part of the Province of Hanover will be provided with electric power, which will serve for the furthering of the minor industries to the widest extent. Of two other peat power stations, that on the Wiesmoor has been in existence two years and the Schweegemoor station since October last year. The latter supplies electric current to six circuits and to the City of Osnabrück, besides producing gas and ammonia by the Mond pro-

cess. It is, furthermore, intended next to cultivate, by means of electric ploughs, &c., a large part of the moor surface. The Wiesmoor station, whose erection was begun two years ago by the Domain Fiskus, has served a useful purpose. It now supplies with electric current not only East Friesland but a part of the Grand Duchy of Oldenburg. Steam turbines are employed for the generation of the current; the boilers are heated with peat sods. Hereabouts, all the peat dredgers, sand dredgers, ploughs, harrows and rollers are worked by electric power. Many hundreds of hectares are also cultivated by implements driven by current drawn from this station, and have given good results, especially the hay crops. The establishment of new stations is of great importance to the potash industry, as they tend to enlarge the area of consumption, and the agricultural utilisation of the moor surface is only possible by means of the regular application of potash manures. For this purpose, 100 kg. per hectare must be applied each year.

RUSSIA.—Imperial sanction has been given to the contracts concluded with Mr. Charles Stewart, an Englishman, for the lease of Crown lands in the neighbourhood of Lake Gokcha in the Caucasus, for the purpose of establishing a hydro-electric station. —*Financier*.

Dundalk.—At the bi-monthly meeting of the Council last week, Mr. P. A. Spalding, the electrical engineer, reported that the contracts for the underground and overhead street mains had been completed.

Dover.—A number of residents have petitioned the T.C. protesting against the system of extinguishing the street lamps after midnight and 1 a.m., by which apparently some 35 per cent. of the recent cost of street lighting is being saved. The *Dover Express*, in commenting on the matter, says that it is desired that every lamp shall be lighted, even if a reduced light is given.

Eccles.—An inquiry was held by Mr. T. C. Ekin, of the L.G.B., on September 11th, relative to the T.C.'s application for sanction to borrow £5,220 for purposes of the electricity undertaking. Mr. Angus, borough electrical engineer, said the growth of the undertaking was chiefly in connection with the extension of power services, and the amounts to be borrowed included £2,000 for new mains, £750 for new services, £750 for transformers, £625 for a new boiler house to accommodate three boilers (one of which was now to be put in), and other smaller expenditures connected with the extension. A reduction in the net profit shown last year was owing to £655 being expended out of revenue for a switchboard, and £75 for a pumping set. After further evidence, the Inspector agreed to amend the application respecting the boiler house to £800, to cover the advance in price of materials and workmanship since the estimate was obtained.

Eccleshall.—After consideration of a scheme submitted by Mr. Balbiani, consulting electrical engineer, of Birmingham, for supplying the district with electric light, the P.C. has decided to inform that gentleman that the parishioners and the Council are favourably disposed towards the proposals, but they prefer that he should apply to the B. of T. for an order rather than give permission themselves.

Edinburgh.—At a meeting of the Corporation Electric Lighting Committee, a motion by Councillor Stevenson to consider as to the disposal of the ascertained surplus of £2,179 on the year's accounts of the electric lighting undertaking to May 15th, 1912, was considered. Councillor Hamilton moved that they recommend the Town Council to place the £2,179 to a suspense account for the purpose of city improvements. This was seconded. Bailie Stewart moved as an amendment that the sum should be placed towards the relief of rates. It was also moved that the amount be applied to the reduction of debt on the undertaking. Ultimately it was decided to submit the matter to the T.C. for decision.

Epsom.—The R.D.C. has consented to the Leatherhead and District Electricity Co. laying mains at Stoke D'Abernon, where several premises are to be supplied.

Galashiels.—The Law and Finance Committee has considered a letter from the Urban Electric Supply Co., Hawick, as to the introduction of electricity into the burgh, and decided to favourably consider the terms of any arrangement which might be submitted by the company, or by the local company which it suggested should be promoted for the carrying out of a suitable undertaking. It having been pointed out that the town was very favourably situated for such a scheme, and that there was valuable power going to waste, which was worth anything from £150 to £200 a year, the Committee's recommendation was adopted.

Glasgow.—Great interest is being taken in the forthcoming Smoke Abatement Exhibition organised by the Corporation. All the most modern electrical apparatus for cooking, heating and lighting will be seen in operation. The School Board is co-operating with the Committee in arranging a series of competitions for girls in cooking and baking by electrical appliances. Other interesting features will be an electrical luncheon and tea-room where the visitors will be able to see their meals cooked by electrical apparatus.

Hartshead (Yorks.).—This village, not to be out-done by the neighbouring townships in the Spen Valley district of Yorkshire, has now got an electricity supply for the illumination of its streets. The current is supplied by the Yorkshire Electric Power Co., at a rental of £2 per lamp, including maintenance, and no care or attention needed on the part of the Hartshead Council.

Hindley (Lancs.).—The Council has had under consideration a communication from the B. of T. in reference to the proposed revocation of the Electric Lighting Order. It was decided to make a strong appeal to the Board for an interview to discuss the desirability of allowing the order to remain in force, the expenses to be paid by the Council. The B.O.T. has since consented to meet a deputation from the U.D.C.

Isle of Man.—An electrical plant has been installed at Noble's New Hospital, the installation consisting of a Walker-Horrocks automatic plant to supply 370 16-C.P. lamps. The generating plant includes a 10-H.P. Austin engine and Vickers dynamo, with a Chloride "Plantoid" 54-cell battery. An electric lift is also installed; Messrs. Baxter & Impey were responsible for the electric lighting work.

Japan.—The Yokohama Electric Co., in order to meet the rapidly increasing demand for a supply of current, has entered into a contract with the Mine Hydraulic Electric Co., for the supply of 5,000 KW., commencing on January 1st next.

Keadby.—Sir Wm. Arrol & Co. have secured the contract for the bridge to be erected accross the River Trent at Keadby; electrical machinery will be fitted for working the bridge, which will be the largest and heaviest of its kind in Great Britain.

Kendal.—For the year ended March 31st last there was a gross profit on the electricity undertaking of £283.

Killarney.—The Guardians are considering a scheme for the electric lighting of the union, which at present is illuminated by gas at cost of £110 per annum. It is calculated that the installation will cost about £424, £324 being for transformers and cables, and about £100 for fittings. The annual cost of lighting is calculated at £50 per annum.

Kingstown.—At the meeting of the Urban Council, a letter was read from Mr. C. J. Reddy suggesting that the Council should consider the amalgamation of the townships of Dalkey, Kingstown and Blackrock with the object of establishing in the combined townships a public and private electric lighting scheme. Mr. Potterton, in proposing that the letter should be sent to the Lighting and Roads Committee for consideration, said that some years ago a lighting system had been projected, a prov. order secured and about £1,500 liabilities incurred. The scheme involved about £50,000. Mr. Evans, in seconding the motion, referred to the operations of a private company concerned in electric lighting, and said that the matter had advanced a certain extent, and they hoped to put a proposition before the Council in a short time.

Loftus-in-Cleveland.—The U.D.C. has decided to discuss with the manager of the Electric Power Co. the question of public lighting by electricity.

London.—ST. PANCRAS.—Having regard to the satisfactory position in which the electricity reserve fund stands, the Finance Committee has decided to recommend the Council that an amount equal to a 1½d. rate from the profits of the electricity undertaking for the past year, should be used for the relief of the rates. Electricity mains are to be extended in various parts of the district at an estimated cost of £654.

BETHNAL GREEN.—The Electricity Committee states that in July last its report dealing with a proposal for supplying electricity in the borough, was referred back for further consideration to ascertain on what terms the Stepney B.C. would be prepared to undertake the administration of the proposed supply. A scheme for the administration of the supply has been discussed, and the Committee understands that the Stepney B.C. would be willing to undertake the administration of the proposed undertaking without seeking to obtain a profit in respect of such work. It, therefore, believes that there is every probability that an agreement could be entered into with Stepney on satisfactory terms for the purpose of working the proposed undertaking. Mr. Snell had, in the Committee's opinion, made sufficient provision in his estimates for the cost of administrative work, and it was as a result of the adoption of his suggestion that preliminary negotiations were entered into with Stepney to see whether the Council would be willing to work the undertaking, it being the opinion of the consulting electrical engineer that this would be the best course to take. The Committee, therefore, again submitted its recommendation, that Mr. Snell's report should be adopted and that a supply should be taken from the Stepney B.C., for approval.

BATTERSEA.—A loan of £7,808 is to be taken up from the L.C.C. in connection with the electricity undertaking. This amount is divided as follows:—Mains, £4,600; house services, £1,200; boiler plant, £1,608; meters, £400. The electrical engineer and chairman of the Electricity Committee have been appointed as the Council's representatives at the conference of metropolitan authorities owning electricity undertakings.

Newcastle Emlyn.—It is announced that the U.D.C. has now accepted the terms of the electricity company for public lighting, after a brief re-trial of oil lamps pending the settlement of points in dispute with the company.

Newmarket.—The U.D.C. has asked the electricity company to erect three 300-C.P. lamps in High Street for the inspection of the Council. Similar lamps are to be provided by the gas company.

Newton-in-Makerfield.—Writing to the local D.C. in response to a request for assistance in securing the renewal of its E.L. Order, the Hon. Arthur Stanley, M.P., said he was bound to admit that one of the principal stumbling blocks in the way of the expansion of electrical matters had been the action of local authorities such as Newton-in-Makerfield. In this case the Council held the Order for six years, but did nothing with in—in other words, the Council would not supply electricity itself nor allow anyone else to do it.

North Wales.—The North Wales Power and Traction Co., Ltd., has applied to the B. of T. for consent to erect overhead lines for the transmission of current from Pen-yr-Orsedd Slate Quarry to Alexander Quarry, Llandwrog.

Paisley.—The General Electrical Co. has obtained permission to fit up within the burgh, by way of experiment and free of cost, a circuit of 12 lamps. These are described as a new type of flame lamp, giving a 400 C.P. greater light than those at present in use. The cost for similar lamps for permanent use would, it is stated, be £10 per lamp.

Pontardawe.—The District Council has agreed to negotiate with Messrs. Gilbertson with a view to the latter supplying electricity to the town. The price is to be 5d. per unit.

Rochdale.—It was reported to a meeting of the Electricity Committee last week that the extension of the electricity works was practically at a standstill owing to the non-delivery of ironwork. This material, it is said, is now difficult to obtain.

Rotherham.—A fire recently occurred at the Corporation electricity works, in connection with an air filter. The fire reached the roof of the building through an exhaust trunk, and was extinguished by the fire brigade.

St. Mellons.—A prov. order for E.L. is being applied for by the South Wales Electrical Power Distribution Co. for the rural district. The company has quoted terms to the R.D.C. for public lighting at Bedwas and Machen Upper, and consideration is deferred until the order is secured.

Shipley.—Electrical extensions and alterations, involving an expenditure of £5,000, are to be undertaken by the District Council. These include the laying of new cables and the provision of new machinery at the works.

Sligo.—The B. of G. is proposing to install an electric lighting plant at the workhouse in view of a rise in the price of gas from £130 to £150 per annum for about 93 burners. Tenders have been received from Messrs. Allen & Grosse, of Belfast, £560; Messrs. Edmundson's Electricity Corporation, Ltd., £670; and the Phœnix Works, Liverpool.

In a long letter from Messrs. Edmundson to the Board, the firm recommended one of their automatic E.L. sets with storage battery. The tenderers were prepared to send a man each quarter to clean the plant, &c., at a cost of £12 10s. per annum. The cost of supplying and erecting a 120-light plant would be £390. For a larger plant, to provide for cooking and heating, the additional charge would be about £280. An economy could be effected by using overhead cable between the buildings. The whole matter of electric lighting has been referred to Mr. P. J. Kilgallen, engineer to the Board, who is also preparing a plan for lighting the town of Sligo, and the Board is seeking further information to discuss at the meeting on September 21st. There is a local prejudice against giving the contract to a Belfast firm.

Southport.—With a view to securing an expert report concerning the state of the electricity and tramways undertaking, the Corporation, on the recommendation of the Electricity and Tramways Committee, recently appointed Mr. S. J. Watson, borough electrical engineer, of Bury, to report upon the electricity department, with special regard to the cost of generating. The matter was referred to at a meeting of the Council on Wednesday last, when Councillor O'Regan called attention to a recommendation instructing their engineer to report on the electrical expert's report and circulate both together. An amendment was moved by Councillor Shaw, and carried, that a copy of the report by Mr. Watson be supplied to every member of the Council separate from any other report, at least a week before the next Council meeting.

Councillor O'Regan also raised the question of deputations, and moved that they refer back the resolution empowering the chairman, vice-chairman and electrical engineer to attend the conference of the Municipal Tramways Association at West Ham. The policy of sending deputations was defended by Ald. Griffiths, and the amendment was defeated, the minutes then being adopted.

Swinton and Pendlebury.—Terms have been agreed between the Lancashire Electric Power Co. and the Council for the supply of electricity in bulk to the Council for a period of five years, with the option of extension to 10 years. Under this agreement the company is permitted to supply direct customers who, by reason of the amount of the demand or the distance of the premises from the Council's mains, cannot be satisfactorily supplied by the local authority. There is a clause requiring the company to obtain the consent of the Council before commencing to supply local power consumers direct other than the Acme Spinning Co., Messrs. Sackville & Swallow, Ltd., and Messrs. J. Berry, Ltd. It had been thought that the steam generated at the new refuse destructor might have been utilised for an electric generating plant, but the engineer consulted by the Council holds out little hope of it being able to generate at a price approaching that at which it is now supplied by the Lancs. Electric Power Co

Truro.—With reference to the E.L. question, mentioned in our last issue, the T.C. has decided that the Committee dealing with the matter shall be empowered to expend up to £20 in seeking expert advice.

Walsall.—Sanction has been received from the L.G.B. to the borrowing of £9,000 for the purposes of the Council's undertaking. The engineer has been instructed to proceed with the laying of ducts for the mains for the Darwall Street sub-station and the tramway feeders in the Litchfield Street, and to obtain prices for the necessary cables. Owing to the increased cost to the electricity department of coal and other charges, the Electricity Committee has appointed a sub-committee to inquire generally, and report on the working of the undertaking; and particularly (1) as to the best means of ensuring the more profitable utilisation of new plant and machinery and new mains; and (2) as to the effect under present conditions, of the increased cost of fuel and any capital and other charges, and the way in which such increases should be met.

Watford.—At the last meeting of the Guardians it was decided to install electric light throughout the workhouse buildings, and to ask Mr. Purse, electrical engineer to the Watford undertaking, to prepare a specification for carrying out the scheme.

The assessment of the electricity undertaking of the U.D.C. has been increased to £2,030 rateable. The question of an appeal is being considered by a Committee.

Wednesbury.—Mr. H. R. Hooper, L.G.B. Inspector, held an inquiry on Friday, last week, into an application by the T.C. for sanction to borrow £3,700 for the purchase of an engine and dynamo.

Windsor.—The T.C. has by a large majority rejected a motion "that before any further contract is entered into with the Electric Light Co. by the Council, an agreement shall be executed to the effect that any profit from Council contracts shall not be included in the purchase amount should the Council at any time determine to purchase the undertaking." A member pointed out that if the resolution was passed, the Electric Light Co. could not tender for street lighting, &c., and the Council would be entirely in the hands of the Gas Co.

Worsley.—There is a prospect of Worsley shortly being in possession of a supply of electricity for lighting or power, as satisfactory arrangements have been come to between the Lancashire Power Co. and the Earl of Ellesmere. The company holds the Worsley Electric Lighting Order obtained by the Council, and has supplied Walkden for the past two years. It is now proposed to extend the cables to Worsley underground, and to establish a sub-station at Worsley. Mr. Taite (general manager) intends to put the work in hand immediately in order that consumers shall receive the supply with as little delay as possible. The Swinton and Pendlebury District Council has decided against extending the distributing mains to the Worsley boundary on the ground that the probable consumption would not justify the heavy cost of laying a cable from the sub-station, and it is possible that the Swinton Council will come to some arrangement with the Power Co. for the latter to supply the numerous large residences in the Broad Oak Park district from the cable which will supply Worsley.

Yarmouth.—As it is expedient to extend plant, machinery and mains, the Electricity Committee has decided to apply to the L.G.B. for sanction to borrow £4,000 for machinery, £1,000 for switchboard, £2,000 for services, and £750 for public lighting mains.

TRAMWAY and RAILWAY NOTES.

Aberdare.—The U.D.C. recently discussed, at length, a recommendation of Mr. Sellon, its engineer adviser, to purchase foreign-made Sandberg rails in preference to British. Mr. Sellon is reported as having said that no British firm would produce rails to his specification, but German firms would do so readily. He had no doubt that the foreign rails were superior. Several "patriots" spoke up for British rails, but eventually Mr. Sellon's recommendation was adopted.

Argentina.—A new electric railway is to be built from Punta Gorda *viâ* San Fernando Anchovena and Vicente Lopez to Belgrano. The line, which will be 85 km. long, will be built from one end and completed section by section, and the necessary materials will be brought along the line as it is constructed.

The company building the electric tramway from the Buenos Aires city boundary to the Tigre has informed the Government of the Province of Buenos Aires that 10½ km. are finished, or say half the line, but, due to unforeseen circumstances, work has been stopped. An extension of 18 months, in which to finish the work, has been applied for. The *Review of the River Plate* understands that want of capital is the cause of the suspension of work.

Australia.—Though the report of Mr. Hay to the N.S.W. Government on the question of relieving the street tramway congestion in Sydney has not been made public, it is stated that he proposes building shallow tramways with street stations at intervals. The tramways will also connect under the harbour with Balmain.

The Chief Commissioner of Railways (N.S.W.) has stated that the electrification of the Newcastle tramways will be carried out shortly, and that a power house to be erected will also supply energy to the railway workshops and yards.

Ayr.—Mr. W. Grant, the Corporation Tramway manager, reports that the number of passengers carried during the year was 3,739,237, an increase of 68,491 over the previous year. The cars ran 385,796 miles, a decrease of 638 miles. The revenue was £15,752, as against £15,492.

Blackpool.—The annual returns in connection with the Corporation Tramways show that the £5,000 made last year represents 20 per cent of the gross profit. The chief feature was the increase of £2,782 in the "circular tour" receipts, and annual contracts amounting to £2,679. There had been an addition to the rolling stock of 17 cars, and since the introduction of car-meters there had been a saving of at least 10 per cent. in the current consumed. Last year the sum was £8,262 for 942,829 miles; in 1909 it was £10,066 for 945,229 miles. The manager states that the experimental steel-tired wheels have proved much preferable to the chilled cast-iron tires. There are now 72 cars, of which 21 are top-deckers.

Bradford.—A long discussion in the City Council took place on the proposed central tramway depôt at Longlands, and ultimately it was decided not to adopt the scheme, by 30 votes to 27.

Canada.—According to the *Times*, an electric railway is to be built to Hudson's Bay, a hydro-electric plant on the Nelson River supplying the necessary electrical energy.

Continental Notes.—Austria.—The first aerial cable railway in Austria—that from Lana to the top of the Vigiljoch—was opened on August 31st. Its total length is 1,153 metres, and it rises to a height of 1,153 metres. It is built on the Ceretti and Tanfani system, four separate steel lines being employed, the standards having a height of 31 metres. The carriages each carry 16 persons, and weigh 3,500 kg. The railway is worked by direct current at 550 volts, obtained from a mountain power-house. The winding motors are of 50 H.P. capacity. The line has taken three years to build, and constitutes the first of the aerial railway units of the local railway system of Austria. Its cost works out at one-fifth that of the rack railway, and one-half that of the fixed cable railway. Its advantages are that it is unaffected by snowfalls, it rises high above forest and plain, and forms no disfigurement of the landscape.—*Electro. und Masch.*

France.—A general movement in electric tramway and railway work is shown by the references to new projects in the French papers. Proposals are on foot for short lines in the neighbourhood of Sedan and Dieppe; in the Department de l'Ovne a loan of 3 million francs has been sanctioned for five lines; tramway extensions are proposed in Pontoise, and extensions and surveys for several lines are sanctioned in the Department of the Yonne.

Spain.—The *Gaceta de Madrid* publishes the application of a company to the Direction-General of Public Works for a concession for the construction and working of a line of electric tramway at Gigon.—*Revue Pratique de l'Electricité.*

Denmark.—The Vestjälland Sugar Factory, which has just been founded with a capital of 5,000,000 kronen, half in shares and half in debentures, proposes to spend a sum of 975,000 kronen in the building of an electric railway, for beetroot transport, and the construction of a power house to supply light and power to drive the railway and small machinery.—*Elektr. und Maschinenbau.*

Dundee.—The new railless trolley car system shows every sign of being a big success. The returns for the first five days show that 6,856 passengers travelled on it: 3,635 of that number were ½d. fares, and 3,221 1d., the revenue being £21. The convener of the Tramway Committee characterises the success as nothing short of phenomenal.

Halifax.—The Corporation Tramways Committee has been authorised by the T.C. to take steps for the promotion of a Bill in the next session of Parliament to enable the Corporation to consolidate and extend its tramway system. It is proposed to extend the system from Triangle to Ripponden in one direction and to Stainland and Elland in another direction. Conferences were recently held with representatives from the outside bodies so as to ensure the necessary financial assistance.

Leith.—The total traffic receipts to May 15th last on the Corporation tramways amounted to £33,850, as against £30,570 in the previous year. The working expenses totalled £18,230. The capital charges amounted to £14,455, and there was a net credit balance of £2,093, as compared with a debit balance of £1,903 in the preceding year. This year the traffic receipts were the highest recorded. The percentage of working expenses to total receipts was 52·54, as against 56·59 in the previous year.

London.—A Commission representing the Berlin railways has recently paid a visit of inspection to the London underground railways, particularly the Metropolitan and District lines. The Commission's conclusions will serve as a basis for discussion on the Berlin railways electrification.

The recent accident on the Piccadilly tube line has drawn attention to the automatic signalling system there installed. The *Railway Review*, in commenting on the accident, attacks the signalling arrangements and suggests that there have been numerous cases of failure which have not received publicity. The chief complaint seems to hinge round the description of the system as "perfect." While, strictly speaking, the *Railway Review's* contention as to imperfection cannot be disputed, yet, in view of the results obtained, the imperfections of the automatic system will cheerfully bear comparison with those of the manually operated signal. Moreover, an instance of failure, quoted as occurring at Turnham Green, turns out to be due to a signal worked from a box, and not automatic in the ordinary sense of the word.

Lincolnshire.—The Light Railway Commissioners have granted an Order, which has been modified and confirmed by the B. of T., authorising the construction of a light railway, about 15 miles long, from Kirkstead to Little Steeping.

Philippine Islands.—Seven electric motor-vans are about to be acquired by the postal authorities in the Philippine Islands for the rapid collection and delivery of letters in Manilla.

South Africa.—In a report on future extensions of the Johannesburg tramway system, Prof. Dobson, manager of the tramways, goes into the comparative merits of tramway, railless, and petrol omnibus systems for outlying suburbs, coming to the conclusion that the plain omnibus would be the least costly and best on tolerably good roads. His estimate, for serving an 8-mile route, of £18,800, includes £12,000, or half the cost (£3,000 per mile) of making 40-ft. macadamised roads, and compares with £34,800 for the railless traction system (also including road making). Prof. Dobson lays much stress on the flexibility of the motor-'bus, suggesting that if necessary it can be tried on other routes and in other districts. He does not, however, point out that this involves fresh road making for the 'buses, or, in the alternative, extravagantly high working costs.

Southampton.—Tenders are invited for the supply of tramway rails required in connection with the proposed reconstruction of the permanent way between Clock Tower and Bargate. The tramway manager has again urged the Council to install meters on the cars, and emphasises the fact that with this installation of meters, bonus schemes for careful driving must be brought up, and, on the other hand, the penalising of drivers who are continuously wasting energy, should be provided for. He further points out that since the six various types of meters were installed on the cars some years ago, which proved to be far from satisfactory, owing to their delicacy, a stronger and heavier type of meter has been brought out specially for this work, and has proved reliable.

U.S.A.—The Philadelphia Electric Co. has signed a contract with the Rapid Transit Co., to supply the latter's railway load of 26,200 KW.; the Transit Co.'s stations will in consequence be shut down or converted into sub-stations, and leased to the supply company. This is the third contract of the kind made this year, says the *Electric Railway Journal*, the others being the Cleveland Railway and the Third Avenue (N.Y.) Railway. Only four years ago the first American contract of this kind was settled between the Chicago Traction Companies and the Commonwealth Edison Co., of Chicago.

According to recent advices, a contract has just been closed for the electrification of the Butte, Anaconda and Pacific Railway, with a 2,400-volt D.C. system. Power will be supplied by the Great Falls Power Co. over a three-phase, 60-cycle, 50,000-volt transmission line to two sub-stations, one at Butte and the other at Anaconda, 26 miles apart. At the sub-stations the voltage is to be stepped down to 2,300 volts, at which pressure the current will be supplied to synchronous motor-generator sets, each consisting of two 1,200-volt compound-wound commutating-pole D.C. generators. and one 2,300-volt, three-phase, synchronous motor. The generators will be arranged to operate in series to supply 2,400 volts to the trolley wire.—*Power.*

Wardle.—A deputation of the D.C. has been appointed to wait upon the Rochdale Corporation Tramways Committee, to ascertain on what terms it will extend the electric tramway along Wardle Road.

York.—The B. of T. has sanctioned the extension of the tramway system to Queen Victoria Street. This will serve the populous South Bank area, and will incidentally furnish an alternative route to the racecourse, the new terminus being a few hundred yards from the back of the grand stand.

TELEGRAPH and TELEPHONE NOTES.

France.—Telephone facilities are being actively installed throughout France, the Consuls-Général of the several departments voting sums of money for the purpose almost daily. In the Department of the Aisne, 550,000 fr. have been recently so voted; Vosges, 485,000 fr.; Deux-Sèvres, 101,500 fr.; Aube, 100,000 fr.; Puy-de-Dôme, 80,000 fr.; Eure, 44,610 fr.; and Yonne, 46,530 fr.—*La Lumière Electrique.*

German Colonial Cables.—It is stated that the German South American Telegraph Co., which laid in 1909 and 1910 a cable from Emden *viâ* Teneriffe to Monrovia, Liberia, on the West Coast of Africa, and which extended the cable from Monrovia to Pernambuco in 1911, proposes to continue the cable from Monrovia to Togoland, then to the Cameroons and subsequently to South-West Africa. By this means the three Colonies would obtain a direct connection with Germany, whereas at present they are

dependent upon British cable communications. The landing place is to be at Lome, in Togoland, and at Duala, in the Cameroons. According to the company's contracts with the Government, the cable to the Cameroons has to be completed by February 1st, 1913, at the latest, whilst that to German South-West Africa will presumably be carried out by April 1st, 1919. The expenditure on the Cameroons cable is estimated at £317,000.

Telephone Inquiry.—At the Congress held at Newcastle-on-Tyne last week, a resolution was passed almost unanimously demanding that a systematic inquiry into the working of the telephone service should be instituted as soon as the arbitration proceedings between the Post Office and the National Telephone Co. were completed. The Deputy-Mayor of Newcastle stated that of 100 local calls that he had made, no fewer than 62 were interrupted, and 49 were cut off before completion of the conversation. On no occasion did he get through within one minute. It was estimated that the service was 20 per cent. slower since the Post Office took over the system. Other delegates corroborated the complaints of bad service.

Walsall.—The town clerk and tramways manager have come to an arrangement with the Postmaster-General for insulating a number of the Government's wires which cross the Corporation trolley line.

CONTRACTS OPEN and CLOSED.

OPEN.

Ashton-under-Lyne.—September 24th. Installation of intercommunication telephones between the departments at the Union Offices, for the Board of Guardians. Mr. G. H. Partington, Clerk.

Australia. — New South Wales.—September 25th. Trunk line switchboard, for the P.M.G.'s department. See "Official Notices" August 23rd.

October 2nd.—N.S.W. Government Railways. Six 1,000-kw. sub-station units to specification No. 357. Specification (10s.) from Electrical Engineer's Office, 61, Hunter Street, Sydney.

October 16th. — N.S.W. Government Railways. Two 5-ton electrically-driven travelling cranes, for the Randwick workshops. Specification No. 365 (5s.). Electrical Engineer's Office, as above.

South Australia.—October 1st. Telephone switchboards at Unley, Adelaide, for the Postmaster-General's department. See "Official Notices" August 23rd.

October 1st. — Telephone switchboards at Norwood, for the P.M.G.'s department. See "Official Notices" August 23rd.

October 22nd.—Telephone switchboard at Port Adelaide, for the P.M.G.'s Department. See "Official Notices" September 13th.

October 23rd.—100 common-battery table telephones, for the P.M.G.'s Department. See "Official Notices" September 13th.

Victoria.—October 2nd. Two vertical sets of electrically-driven rotary pumps, for the Melbourne City Council. See "Official Notices" August 16th.

October 22nd. Fourteen sections of common-battery multiple switchboard, for the P.M.G.'s department. See "Official Notices" September 13th.

Western Australia.—November 5th. Telephone switchboards to Stores Schedules 222 and 223, for the P.M.G.'s department, Perth. See "Official Notices" to-day.

Austria.—Vienna.—November 30th. Plans are required for the erection and operation of an electrically-worked municipal central clock installation. Particulars, Magistratabteilung V, Vienna.

Trieste.—September 23rd. Twelve cranes of 1,500 kg. capacity are required for the Molo della Sanità. Half must be delivered complete ready for erection within 6, and half within 12 months. Particulars from the Technische Abteilung der k.k. Lägerhauser, Trieste.

Bulgaria. — October 17th. The District Administration of Finances in Sofia is inviting tenders for the supply and erection of the mechanical and electrical plant required in connection with the power transmission installation to be laid down at the State collieries at Pernik.

Costa Rica. — December 9th. Tenders are invited for the building and working of an electric tramway between Alajuela and Grecia, a distance of 18,100 m. Particulars from the Secretaria de Fomento, San José.

Dundee.—September 23rd. Electric lighting at Carolina Shed, for the Harbour Trustees. Particulars from General Manager of the Dundee Harbour Trust.

Gravesend.—September 21st. Small coal (2,500 tons) for the Corporation electricity works. The Electrical Engineer.

Halifax.—September 24th. Electrical fittings for six months, for the B. of G. Mr. A. T. Longbotham, clerk, 4, Carlton Street.

Isle of Thanet.—General stores for a year, for the Isle of Thanet Electric Tramways and Lighting Co., Ltd. See "Official Notices" to-day.

Large Conduit Order.—One million feet of conduit, with accessories. See "Official Notices" September 13th.

Leeds.—October 7th. The Tramways Committee of the Corporation invites tenders for the supply and erection of a steel building at the permanent way depôt, Leeds. Mr. J. B. Hamilton, general manager.

Liverpool.—September 24th. Electrical supplies for a year, for the West Derby B.G. Mr. H. P. Cleaver, Clerk, Brougham Terrace.

London.—L.C.C.—September 24th. Electric spark gaps in brick cells for sub-stations. See "Official Notices" August 23rd.

Hammersmith.—September 25th. A.C. motors, for the Corporation. See "Official Notices" September 13th.

Hackney.—Tenders are to be invited for the supply of 100,000 pairs each of white open-type arc lamp carbons and yellow flame arc lamp carbons.

Fulham.—September 25th. 5,000 tons of nutty slack coal, for the B.C. See "Official Notices" to-day.

Southwark.—October 2nd. 440 yd. or 880 yd. of ·1 × ·05 × 1 and 440 yd. or 880 yd. of ·05 × ·03 × ·05 cable, for the B.C. See "Official Notices" to-day.

Lossiemouth.—September 28th. Gas producer plant, engines and dynamos, battery, crane, overhead mains and public lamps, for the T.C. See "Official Notices" September 6th.

Manchester. — October 1st. Permanent way points, tongues, and hardened steel centres, for the Tramways Committee. Specifications and forms of tender (£1 1s. returnable) from Mr. J. M. McElroy, general manager.

Mexborough. — October 5th. Turbo-generator, condenser and switchgear, for the U.D.C. See "Official Notices" September 13th.

Nuneaton.—September 30th. Cast-iron and steel pipework, valves and accessories, for the Corporation. See "Official Notices" to-day.

Sweden. — October 15th. Tenders are invited for machinery required at the Porjus Power Works, viz:—(1) Electric lift for passenger and goods, with a carrying capacity of 1,000 kilogs; (2) two electrically-driven oil pumps, each with a pumping capacity of 100 litres of oil per minute, or 200 litres as an alternative at a drawing height of 22 metres; and (3) three electrically-driven water pumps, each with a pumping capacity of 1,500 litres of water per minute at a total drawing height of 20 metres. Particulars from "Förestandaren, Kungl. Vattenfallstyrelsens Elektrotekniska Byra," Stockholm. Specifications, &c. (in Swedish), together with drawings, may be seen at the Commercial Intelligence Branch of the Board of Trade, London, E.C.

Taunton.—The T.C. invites tenders for 2,500 tons of steam coal for the electricity works. Particulars from the electrical engineer, Mr. A. J. Howard.

Watford.—September 30th. The U.D.C. is inviting tenders for one electrically-driven pumping plant. Specifications and forms of tender (£2 returnable) from Mr. D. Waterhouse, Engineer and Surveyor, Watford.

CLOSED.

Aberdare.—The U.D.C. has accepted the tender of the Lancashire Dynamo Co., Ltd., for electric light plant, at £4,439, and that of Messrs. Wm. Griffiths & Co., Ltd., for the construction of the new electric tramways, at £45,870. On the advice of Mr. Sellon the Sandberg rails are to be made by the Phœnix Co., of Belgium.

Ashton-under-Lyne.—The Electricity Committee has accepted the following tenders:—

Goodbrand & Co.—One fuel economiser.
Nichols Bros.—Two boiler feed pumps.
British Westinghouse Electric Co.—Converting machinery.
Dempster & Co.—Coal-handling plant.

Bexley.—The U.D.C. has accepted the tender of the British Insulated and Helsby Cables, for cable, at £95, for the extension of the mains to Halfway Street.

Bolton.—The B. of G. has accepted the tender of the Austin Motor Co., Ltd., at £445, for a motor ambulance.

The Watch Committee of the T.C. has accepted the tender of Mr. B. Bleasdale, of Bolton, for electrical fittings.

British Columbia.—The contract for the construction of the big dam at Jordan river, B.C., for the British Columbia Electric Railway Co., has been awarded to the Puget Sound Bridge and Dredging Co., of Seattle. The dam will be 800 ft. long and 115 ft. deep, and will be modelled after the Ambursden type of reinforced concrete structure.

Australia. — According to the *Australian Mining Standard*, the Prahran-Malvern (V.) Tramway Trust has accepted the following tenders in connection with tramway extensions to Kew, Hawthorn, Malvern, Caulfield and St. Kilda :—

Special work (points and crossings).—Messrs. Edgar Allen & Co., £8,875.
Overhead construction and erection, feeders, cables, &c.—British Insulated and Helsby Cables, Ltd., £10,797.

The same contemporary says that tenders have been accepted by the Postmaster-General in connection with telegraphic and telephone branches of the department, amounting to £70,000, and including the following :—

Hoffmann Brick and Potteries, Ltd., Melbourne.—24,771 glazed earthenware conduits, six ducts, at 8s. 3½d. each, £4,076; and 51,621 conduits, four ducts, at 2s. 3½d. each, £5,914.
Callender's Cable and Construction Co., Ltd., through Noyes Bros.—10½ miles of cable, £3,569; 11 miles paper-insulated lead-covered cable, £2,629.
James Miller & Co.—45,000 lb. of twine, £1,942.
India-Rubber, Gutta-Percha and Telegraph Works Co., Melbourne.—Brushes, speiders, zincs and cells, £789.
A. J. Sage & Co.—6,460 cells, £669.
British Insulated and Helsby Cables, Ltd.—Copper tapes and bronze and copper wire, £34,262.
W. T. Henley's Telegraph Works Co., Ltd.—80 miles paper-insulated lead-covered cables, £7,170.

Brighton.—The B.G. has accepted the tender of Mr. H. J. Galliers, of Brighton, for electrical fittings, at £42.

Croydon.—The Infirmary Committee of the Guardians has provisionally accepted the tender of Messrs. Waygood, at £647, for the installation of two electric lifts at the infirmary.

France.—The Compagnie des Chemins de Fer de l'Etat have just placed orders for 80 motor-cars for service on the Paris suburban lines, with the Ateliers du Nord de la France, and for 20 with the Compagnie de Chemins de Fer d'Ivry. The price per motor is 133,000 fr. The orders for electric equipment (cables, controllers, lighting and heating apparatus, &c.) were shared between the Thomson-Houston Co. and the Ateliers de Constructions Electriques du Nord et de l'Est.

Government Contracts.—The following tenders have been accepted during the past month by the Government departments named :—

ADMIRALTY, CONTRACT DEPARTMENT.

Breakers and contactors.—Whipp & Bourne.

INDIA OFFICE, STORE DEPARTMENT.

Apparatus.—Marconi's Wireless Telegraph Co.
Cable.—Siemens Bros. & Co.
Dynamo, &c.—J. Stone & Co.
Telephones, &c.—Peel-Conner Telephone Works, Ltd.

CROWN AGENTS FOR THE COLONIES.

Train lighting cells.—Chloride Electrical Storage Co., Ltd.
Electric dock crane.—Babcock & Wilcox, Ltd.; Stothert & Pitt, Ltd.
Telegraph poles.—Bullers, Ltd.
Telephone switchboard.—Western Electric Co., Ltd.

H.M. OFFICE OF WORKS.

Electric lamps.—A.E.G. Electric Co.; Radium Electric Co.; Pope's Electric Lamp Co., Ltd.

GENERAL POST OFFICE.

Protective apparatus.—The British L. M. Ericsson Manufacturing Co., Ltd.
Telegraphic apparatus.—The Gell Telegraphic Appliances Syndicate, Ltd.
Telephonic apparatus.—London Electric Wire Co. and Smiths, Ltd.; Automatic Telephone Manufacturing Co., Ltd.; The British L. M. Ericsson Manufacturing Co., Ltd.; Siemens Bros. & Co., Ltd.; Western Electric Co., Ltd.; British Insulated and Helsby Cables, Ltd.
Telegraphic cable.—Siemens Bros. & Co., Ltd.; Western Electric Co., Ltd.
Telephonic do.—Western Electric Co., Ltd.; Johnson & Phillips, Ltd.; London Electric Wire Co. and Smiths, Ltd.; British Insulated and Helsby Cables, Ltd.; Callender's Cable and Construction Co., Ltd.
Dry cells.—Siemens Bros. & Co., Ltd.
Earthenware ducts.—Albion Clay Co., Ltd.
Insulators.—J. Bourne & Son.
Telegraphic ironwork.—T. W. Lench, Ltd.; Bullers, Ltd.; F. W. Cotterill, Ltd.
Wheatstone telegraph paper.—Waterlow & Sons, Ltd.
Zinc rods.—Eyre Smelting Co., Ltd.
Telegraphic wire.—Shropshire Iron Co., Ltd.; Dorman, Long & Co., Ltd.; R. Johnson & Nephew, Ltd.
Four electric lifts, S.W. District Office, London.—Medway's Safety Lift Co.
Lattice masts, Wireless Telegraph Station, St. Just, Cornwall.—R. W. Blackwell & Co., Ltd.
Telephone exchange equipment, London (Brixton, S.W., Gerrard Exchange, W., and Walthamstow, E.), Liverpool (Bootle) and Glasgow (Hillhead).—Western Electric Co., Ltd.
Do., Barrow-in-Furness.—Peel-Conner Telephone Works, Ltd.
Do., Post Office, Salisbury.—Peel-Conner Telephone Works, Ltd.

Halifax.—The Guardians have accepted the tender of the General Electric Co., Ltd., for the supply of a portable X-ray switchboard to work coils at the Halifax Hospital; also for a tube stand, with attachments.

Houghton-le-Spring.—The R.D.C. has accepted the tender of Messrs. S. Stobart & Co., of Newcastle-on-Tyne, for the installation of the electric light at the hospital, at £32.

India.—Messrs. Crompton & Co., Ltd., have entered into a contract with the Nagpur Electric Light and Power Co., Ltd., for a complete plant to generate and supply electricity in Nagpur. The contract includes generating plant, about 13 miles of cable for the street lighting, and 600 street lighting brackets.

Llandrindod Wells.—A contract for four "Bennis" high-duty smokeless and gritless coking stokers and self-cleaning compressed-air furnaces, for Lancashire boilers, has been placed with Messrs. Ed. Bennis & Co., Ltd., by the Llandrindod Wells Electric Power and Lighting Co.

London.—SHOREDITCH.—The B.C. has accepted the tender of Messrs. Siemens Bros. & Co., Ltd., for reinsulating with paper and lead a quantity of old rubber-insulated cable, at £189 per mile for ·15 cable, and £278 per mile for ·25 cable.

BERMONDSEY.—The B.C. has accepted the tender of Messrs. Davidson & Co., Ltd., at £20, for the supply of an electric fan.

Luton.—The T.C. has accepted the tender of the British Westinghouse Electric and Manufacturing Co., Ltd., for a 500-KW. converter and transformer, at £1,246.

Malvern.—The U.D.C. has accepted the tenders of the South Wales and Cannock Chase Coal Co., Ltd., and Mr. W. A. Thompson, of Malvern, for coal for the electricity works.

Newport (Mon.).—The Electricity and Tramways Committee of the T.C. has accepted the tender of Messrs. Edgar Allen and Co., Ltd., for special track work for the tramways, at £665.

Paisley.—The Electricity Committee has accepted tenders for coal as follows :—Messrs. James Wood & Co., 2,500 tons Viewpark coal, at 12s. 7d. per ton; 2,000 tons Bothwell Castle coal, at 12s. 9d. per ton; and 2,500 tons Greenfield coal, at 13s. 0½d. per ton.

Rochdale.—The Corporation has accepted the tender of Messrs. W. T. Glover & Co. for the supply of cable to the electricity department for the next 12 months.

Rosario.—The municipality has received the following tenders for the supply of arc lamp carbons :—

Cia. India-rubber	$16,460	Buxton, Casini & Co.	$19,480
Siemens, Schuckert	18,135	Cia. Industrial de Electricidad	17,280

Review of the River Plate.

Rotherham.—The Corporation has accepted the tender of the Reason Manufacturing Co., Ltd., for the next year's supply of electrolytic meters.

Southampton.—The T.C. has accepted the tender of Mr. J. Douglas, at £879, for carrying out alterations and additions to Portswood tramcar depôt. The following tenders have been accepted for supplies of coal to the electricity department :—

Bradbury, Son & Co., Ltd.—1,500 tons Newbury, 12s. 9d. per ton, and 2,000 tons Tamworth, 16s. 10d. per ton.
J. R. Wood & Co., Ltd.—2,250 tons North Country, 14s. 1d. per ton.
Phœnix Wharf and Coal Co., Ltd.—2,250 tons North Country, 14s. 1d. per ton.
Myers, Rose & Co., Ltd.—2,800 tons Gedling, 16s. 9d. per ton.

Wallasey.—The Sun Evaporator Co., Ltd., are supplying superheaters and evaporators to the electricity works, and the Davenport Engineering Co. a water-cooling tower.

The offer of Messrs. Hanchett, Burnett & Co. has been accepted for new transformer windings.

Walsall.—The tender of Halley's Industrial Motors, Ltd., has been accepted by the T.C. for the supply of a 34-H.P. motor tower wagon.

Warrington.—The B. of G. has accepted the tender of Mr. Harry Rogers for electrical requisites.

FORTHCOMING EVENTS.

North-Eastern Counties Electrical Exhibition.—Open daily to Saturday, September 28th inclusive. At the Exhibition Hall, St. Mary's Place, Newcastle-on-Tyne.

Municipal Tramways Association Conference and Exhibition.—At West Ham. Wednesday, September 25th, to Friday, September 27th. For programme see our issue of August 23rd, page 305.

Roumanian Oil-Well Fire and Electricity.—In connection with the fire which occurred last month in the Moreni oilfield, the Government Inspector reports that it was due to a spark from an electric motor, and advises that electricity should be forbidden as a motive power in oilfields, on the ground that electric motors as commercially supplied are so imperfect that they must produce sparks, either directly or through accessories, and that these sparks have often caused fires. The Inspector's recommendation is already arousing great opposition from those aware of the many advantages of electrical installations on oilfields, and it is not likely to be adopted without grave consideration. The success hitherto attained by electric motors has been based partly on the absence of fire and sparks inseparable from a boiler installation, and for lighting a derrick and buildings electricity has a positive advantage in being less dangerous as regards fire than any other source of artificial light. Moreover, the recommendation, if carefully read, does not condemn electric motors, but only imperfect ones supplied commercially. The remedy would appear to be a higher class of goods.

NOTES.

Miners' Safety Lamp Tests.—Particulars have been issued by the Home Office regarding tests which miners' safety lamps should pass in order to be admitted to the list of "approved" lamps in accordance with Sec. 33 of the Coal Mines Act, 1911. The Committee appointed to deal with the matter does not propose that each individual lamp used in a coal mine shall be tested, but that no lamp shall be adopted that does not conform in all particulars with an official specification which is the outcome of the official test. In the case of an electric lamp, it is to be dropped, complete with its glass, from a height of 6 ft. upon a wooden floor five times in succession. A different glass is to be employed each time, and not more than one broken glass is to be permitted in the five tests. If two glasses break the lamp is to undergo five more tests, and if the glass breaks in two of these it will be held to fail. The test will be carried out with the battery removed and a dummy of the same weight substituted. The lamp should give not less than 1½ C.P. after 10 hours' use, and, as regards the danger of causing explosion, it will be tested by having the light switched on and off while it is in an explosive mixture. Another requirement is that no liquid shall escape from the battery when the lamp is turned upside down. The Committee thinks it desirable that the light should be well distributed outside the lamp, and that a movable reflector should be provided to concentrate or shield the light at will.

The Home Office station at Eskmeals, Cumberland, is now open for the reception and testing of lamps. Under Sec. 33 of the Act, after January 1st next no safety lamp must be used by any person employed in a mine, unless it is of a type for the time being approved by the Secretary of State. Instructions as to the submission of lamps to the official test are given in a memorandum, which can be obtained on application to the Home Office.—*Times.*

Glover's Almanac.—In the sheet for September 8th an extract from the *Journal* of the I.E.E. on the subject of meter errors is attributed to Mr. C. Ashmore Baker, of Westminster, who writes pointing out that the words used are, as a matter of fact, those of Mr. Charles Alfred Baker, of the London County Council, to whom the credit should be given.

Educational Notes.—University College, London.—In connection with the opening of the Session, the Provost, the Dean and the Vice-Dean in the Faculty of Engineering will attend from 10 a.m. to 1 p.m. on Monday, September 30th, and Tuesday, October 1st, for the purpose of giving advice and information to students entering the College.

Prof. J. A. Fleming will give a public introductory lecture on "The Sources of Energy Available to Man," on Wednesday, October 9th, at 5 p.m. Dr. Dugald Clerk, F.R.S., will preside at this lecture.

L.C.C. School of Building.—The session opens on September 23rd.

Battersea Polytechnic.—The new session commenced on Tuesday last. Full day and evening courses are provided in science and engineering, and students attending the Polytechnic may be registered as internal students of the University of London. In the Electrical Engineering Department a new course in Electric Lighting and Illumination will be held, and new equipment is being provided in connection with the subject of Electric Traction.

Borough Polytechnic Institute, London, S.E.—The Polytechnic reopens on September 23rd for courses in electrotechnics, electric wiremen's work, electrical design and workshop drawing. See our advertisement pages to-day.

Municipal Technical Institute, West Ham, E.—Notice is given in our advertisement pages to-day regarding day and evening courses in electrical energy.

The Technical College, Finsbury.—The evening courses in electrical engineering begin on September 20th. The lectures of the advanced course on Monday evenings will be given by Prof. Silvanus P. Thompson during the autumn term on dynamo and motor design and on alternating-current work; after Christmas a special course of lectures on alternating-current motors will be given by Mr. J. K. Catterson-Smith. On Wednesday evenings, commencing October 2nd, Prof. Thompson and Mr. Howgrave-Graham will lecture on magnetism, electric measurements, illumination, &c. In the Mechanical Department, in January, Mr. Wimperis will deliver a special course of lectures on "The Application of Power to Load Transport."

Electric Lighting Plant Valuation.—Mr. Edwin Bolton, Carbrook, Larbert, presiding over the Valuation Appeal Court for the western division of Stirlingshire last week, heard an appeal by Sir Walter Menzies, M.P., Culcreuch, Fintry, against the valuation of £20 placed on a workshop and sawmill and £15 on an electric lighting plant. According to a report in the *Glasgow Daily Herald* Sir Walter was not represented at the Court, but he sent a letter, in the course of which he said that after some discussion at the Parish Council meeting he had agreed to the valuation of the workshop and sawmill being placed at £16. With reference to the electric lighting plant, this was installed in 1895, and had always been considered as part and parcel of the old mill building. Mr. Barr, the assessor, explained that Sir Walter now used the plant for supplying light not only to his own house but also to a neighbouring residence, and this, of course, made him liable to valuation. Mr. R. A. Hill, writer, Stirling, thought Sir Walter ought to have been represented at the Court if he wished to oppose the finding of the assessor. The Court ultimately decided to dismiss the appeal.

In Memory of Ebenne Lenoir.—The little town of Mussey-la-Ville (Luxembourg) was *en fête* recently, the occasion being the inauguration of a commemorative plaque on the house in which the late M. Ebenne Lenoir, one of the pioneers of the gas engine, was born in 1822.

Institution and Lecture Notes.—Illuminating Engineering Society, U.S.A.—The sixth annual Convention of this Society was opened on Tuesday, 16th inst., at Niagara Falls, Ont., and was to close yesterday. Many papers on gas and electrical illumination were down for reading.

Appointments Vacant.—Electrical engineer, for the Liverpool City Council (£1,000); shift engineer, for the City of London Asylum, Dartford (34s.); instructor for electric wiremen's classes, for the Wimbledon Technical Institute. See our advertisement pages to-day.

Annual Outings.—The employés of Messrs. Elliott Bros., electrical engineers, held a most enjoyable outing on September 7th. A special steamer left Greenwich Pier at 2.30 for Kew, where tea was partaken of, the return trip being made at 8 o'clock. During the afternoon, the swimming club held their ½-mile championship race from the "Queen's Head," Mortlake, to Barnes Bridge, for the challenge shield and medals for the first three competitors finishing the course. Over 300 employés took part in the outing, which was organised and carried through by the Amusements Committee, acting in conjunction with the Swimming Club.

On Thursday, September 12th, the staff and workpeople of Messrs. J. H. Heathman & Co. had their annual river trip. Over 100 of the staff and friends assembled at Richmond, and proceeded by launch to Hampton Court, where a stop was made to visit the gardens; afterwards they went on to Laleham. During the trip an excellent luncheon and tea were provided, while music beguiled the fleeting hours. Fortunately, excellent weather prevailed, making the trip most enjoyable. From a short speech made by Mr. Heathman, as Richmond was reached on the return journey, we gather that the recent fire caused very little disturbance at the factory, thanks, as he said, to the way in which his efforts had been seconded by the staff and workpeople.

The annual outing of the employés of Messrs. Stegmann & Co., of Clapham Junction, S.W., took place on Saturday, August 31st, to Southend.

Copper.—The relationship of supply to demand in the copper market is discussed by the writer of an article in the *Financier* of September 5th. He quotes the National Conduit and Cable Co. (U.S.A.) to the effect that, although that market has not been so active recently, there is every reason to anticipate a continuance of high prices. The very cheap lots to be had in July have mostly disappeared. The Copper Producers' Association shows a marked increase in refinery production. This increase is given as 6,700 tons (July over June). At this rate, the production of marketable copper for the year 1912 would be in the neighbourhood of 735,000 tons, an increase of 95,500 tons on 1911. The London market is, on the whole, strong. A good share of recent activity came from bull covering. Germany, as usual, appears to be absorbing copper on a heavy scale, and English manufacturers are also said to be booking good orders.

Fatality.—A correspondent reports that an apprentice at the Sheffield works of the Provincial Motor Cab Co. was killed on Tuesday. He took hold of a displaced electric conduit pipe which contained a live wire, and he was unable to release his hands. Hearing his shrieks, the workpeople rushed to his assistance, but they had to sever the pipe before the lad's hands could be loosened. The flesh was burnt to the bone. He was in a state of collapse, and was hurried to the hospital, but he died before medical aid could be given.

The Extraction of Nitrogen.—The commercial success of undertakings engaged in the extraction of nitrogen from the atmosphere is claimed to have hitherto been dependent upon the possession of large water-powers able to yield cheap power, and for this reason Norway is the centre of the industry. On the other hand, water-power in Sweden is said to be costly, and there is only one works—the Stockholm Superfosfat Fabriks A.B.—which is based upon the use of water-power. In this connection it is reported from Gothenburg that Messrs. Bjorne and Torsell, Swedish engineers, some time ago devised a different process for the extraction of nitrogen from the atmosphere, whereby the use of water-power is declared to be made of subsidiary importance. A company was formed in Gothenburg a year ago, under the title of the Kvafveindustri, for the purpose of working the method, and the results obtained by the experimental works have proved satisfactory. It is now intended to erect a large factory for the working of the process on a considerable scale.

Legal Query.—The following paragraph, received after part of this issue had gone to press, should be added at the end of our "Legal Query" column, page 480 (reply to "Lex"):—There does not appear to be any statute or decision which bears upon the latter part of the question—namely, Is a local authority obliged to publish the amounts of tenders made, or to disclose them to any ratepayer who may apply for the information? The statute merely provides that tenders shall be advertised for; but it does not go on to state that the results of the advertisement shall be made public, or that a ratepayer may demand the information. Nor can it be said to be the general duty of a local authority to disclose information of this kind, because it is common practice in statutes relating to local government to provide that certain information shall be at the disposal of ratepayers on payment of specified fees.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Officials.—From an Irish paper we gather that Mr. R. B. Granger, borough electrical engineer of Limerick, has resigned his position. A successor is to be appointed within two months; the candidates at the time of Mr. Granger's appointment are to be asked to send in applications, the qualifying examination to apply. Intending applicants may, with advantage, read the *Limerick Chronicle*, of September 7th. Mr. Granger has only recently taken up the Limerick appointment, in fact the Paisley Electricity Committee has just sent him a letter appreciative of his services, and is discussing the appointment of his successor at Paisley.

The Islington Electric Lighting Committee have resolved to recommend to the B.C. that an honorarium of five guineas shall be presented to each of the under-mentioned officials as a recognition of their promptitude in extinguishing the fire on the switchboard at the electricity works on Monday, 9th inst., and for the expeditious manner in which they succeeded in restoring the normal supply in the borough:—Mr. M. J. Allward, station superintendent; Mr. T. A. G. Margary, mains superintendent; Mr. Chas. F. Wade, engineer-in-charge; Mr. St. Clair Compton, assistant engineer-in-charge; and Mr. J. B. Palmer, representative of the British Westinghouse Co., who is in charge of the constructional work on the new switchboard which was very seriously damaged by the fire.

Mr. H. W. Lawrence has left the Newcastle-on-Tyne Electric Supply Co. to take up the position of station superintendent under the Sudan Civil Service, and will be stationed at Khartoum.

The Battersea B.C. has appointed Mr. Frederick Tyrrell as commercial assistant to the electricity undertaking.

The note which appeared in our last issue referring to "Mr. Alfred Wm. Barnett, chief electrical engineer at the Ocker Hill generating station," should have read "Mr Wm. A. Barnett, shift engineer at the Ocker Hill station," the latter gentleman being the recipient of various presents on the occasion of his marriage to the lady mentioned. The error on the part of our correspondent, for which we offer our apologies, is to some extent explained by the similarity of the names and occupations of the gentlemen referred to.

On the occasion of his marriage, Mr. L. de Rome, of the Keighley Corporation electricity staff, has been presented by his colleagues with a barometer and three flower vases.

Mr. C. H. Thomas, who is leaving the Stoke-on-Trent electricity works to take up a position with the Llanelly Electric Power Co., under Mr. P. J. S. Tiddeman, the former chief at Stoke, has been presented by his colleagues with a dinner service and pair of vases.

The Worcester T.C. has increased the salary of Mr. Ronald Smith, chief assistant at the electricity works, from £156 per annum to £167, with a further annual increase of £11 for three years. Small increases have also been given to Mr. E. Page, station superintendent, and Mr. H. Smith, shift engineer.

The staff of the Exeter City Electricity Department have presented a barometer to Mr. R. C. Tothill, late official canvasser for the department, on his resignation.

The Harrogate T.C. has been recommended by the Lighting Committee to increase the salary of the borough electrical engineer by £50 a year.

Mr. Geo. D. Malcolm, assistant mains superintendent at the Borough Electricity Works, Tynemouth, has been appointed distribution engineer to the Stockton-on-Tees Electricity Department.

Mr. H. W. Wolton has resigned his position on the commercial staff of the City of Birmingham electric supply department to take up an appointment with the A.E.G. Electric and Manufacturing Co., Ltd., as their power representative for the Midlands.

Mr. E. Simister, who had been offered an appointment at Salford, has decided to remain with the Bury electricity department as canvassing engineer.

Tramway Officials.—Mr. Chas. Burgess, tramway manager at Wigan, who had been appointed general manager of the tramways at West Hartlepool, has been presented by the Corporation tramway staff and employés at Wigan, with an oak smoker's cabinet.

General.—Mr. C. Hamilton Wickes, H.M. Trade Commissioner for the Dominions of Canada and Newfoundland, has recently visited the works of the General Electric Co., Ltd., at Witton, near Birmingham, upon a tour of inspection, prior to his departure from this country to take up his new duties.

Mr. H. J. Loughlin, late of the British Westinghouse and the Chloride Electric Storage Companies, sails for Iquique, Chile, on the 25th inst., under a three years' contract, to take up a position on the staff of J. K. Robinson.

Mr. Percy A. Sanders, A.M.I.M.E., has been elected a director of the firm of Davey, Paxman & Co., Ltd. Mr. Sanders originally served his apprenticeship with the firm, and was for several years with the General Electric Co., at Schenectady, U.S.A., subsequently holding an important position with the British Westinghouse Electric and Manufacturing Co., Ltd., at Manchester.

The following War Office appointment is announced in the *London Gazette* for September 13th:—"Major Algernon H. Dumaresq, Royal Engineers, to be Inspector of Electric Lights at the War Office, vice Lieut.-Col. E. C. Seaman, Royal Engineers."

At Middlesbrough Parish Church on September 11th, the marriage took place of Mr. Jas. Robert Beard, of Newcastle-on-Tyne, and Miss Gertrude Robinson, second daughter of Councillor W. H. Robinson, of Middlesbrough.

The marriage took place at St. David's Church, Beaufort, on September 9th, of Mr. David Arthur Pritchard, electrical engineer, of Westgrove, Pennsylvania, U.S.A., and Miss Marie Llewelyn, eldest daughter of the vicar of the parish, the Rev. D. J. Llewelyn.

A Montreal paper states that, on 5th inst., Mr. W. D. Matthews, a director of the Canadian General Electric Co., was elected vice-president, to fill the place of the late Mr. H. P. Dwight. The vacancy on the board caused by the death of Mr. Dwight has been filled by the appointment of Mr. F. Gordon Osler.

NEW COMPANIES REGISTERED.

Rural Districts Electric Undertakings, Ltd. (124,045).—Registered August 30th, by Herbert Smith, Goss, King & Gregory, 62, London Wall, E.C. Capital, £50,000 in £1 shares. Objects: To carry on business as electricians, mechanical engineers and suppliers of electricity for light, heat, motive power, traction, communication or otherwise, generators, accumulators, distributors and suppliers of electricity, to construct, lay down, establish, and fit all necessary power stations, cables, wires, lines, accumulators, lamps, and works. The signatories (with one share each) are:—W. R. Smith, 6, Lawley Street, Lower Clapton, N.E., solicitor's clerk; C. A. Warter Wilson, 5, Norfolk House Road, Streatham, S.W., clerk; C. Anning, Ellerslie, Sylvan Road, Snaresbrook, clerk; J. Barnes, 7, Walcot Gardens, Kennington, S.E., accountant; H. P'Anson Jones, 62, London Wall, E.C., solicitor; F. D. Billett, 5, Blurton Road, Lower Clapton, N.E., clerk; W. R. Tompkins, Morecroft House, Brampton Road, St. Albans, clerk. Minimum cash subscription, 500 shares. The first directors (to number not less than two or more than seven) are O. H. Valpy, 36, Sloane Court, S.W.; J. H. P. Berthon, 16, Randolph Road, W.; E. H. Lyddon, 122, Bute Street, Cardiff; H. T. Harrison, 11, Victoria Street, S.W.; and S. G. Leech, 91, York Street, Westminster, S.W. The two last named are managing directors; qualification, £100; remuneration, £50 each per annum (£25 extra for chairman). Registered office, 91, York Street, Westminster, S.W.

Universal Cable Code (Parent) Co., Ltd. (124,148).—This company was registered on September 6th, with a capital of £4,000 in 2,500 7 per cent. cumulative preference shares of £1 each and 30,000 ordinary shares of 1s. each, to produce, advertise and publish (yearly or otherwise) a publication to be called the "Universal Cable Coding System," and to adopt an agreement with C. Rutherford. The subscribers (with one share each) are:—B. A. Biddulph, 11A, Frederica Road, Chingford, superintendent; H. Horne, 61, Stanwick Mansions, West Kensington, W., superintendent. Private company. The number of directors is not to be less than two or more than five; the subscribers are to appoint the first; qualification (except first director), £25; remuneration as fixed by the company. Registered office, Halton House, 20-23, Holborn, E.C.

Landis & Gyr, Ltd. (124,087).—This company was registered on September 3rd, with a capital of £2,000 in £1 shares, to carry on the business of electrical and general engineers, manufacturers of and dealers in all kinds of plant, machinery, engines, appliances, apparatus and implements used in connection with generation, distribution, supply, accumulation and use of electricity, &c. The subscribers are:—K. H. Gyr, Zug, Switzerland, manufacturer of electrical apparatus, 400 shares; L. R. Lester, Rosemary Cottage, Chipstead, Surrey, engineer, 200 shares. Private company. The first directors are K. H. Gyr, L. R. Lester and H. Landis. Registered office, 28, Denman Street, S.E.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrical and Industrial Investment Co., Ltd. (122,256).—Particulars of two series of £100,000 debenture stock, with interest at 5½ per cent. and 4½ per cent. respectively, and secured by trust deeds dated August 12th, 1912, pursuant to Sec. 23 (3) of the Companies' (Consolidation) Act, 1908, the whole amount being now issued. Property: The company's undertaking and property, present or future. Trustees: Electric and General Investment Co., Ltd.

"Cedes" Electric Traction, Ltd. (109,698).—Return dated July 13th, 1912 (filed July 20th). Capital, £20,000 in £1 shares; 3,000 shares taken up; £3,000 paid. Mortgages and charges: Nil.

Clontarf and Hill of Howth Tramroad Co.—The report of the directors for the year ended December 31st, 1911, shows a balance available for division of £1,279. It is proposed to pay a dividend for the past half-year at the rate of 3 per cent. per annum, with one shilling per share bonus out of the accumulated surplus profits over and above the dividends paid during the past five years, and to carry forward £279 to next account. An interim dividend at the rate of 3 per cent. per annum was paid in respect of the half-year ended June 30th, 1911.

Winnipeg Electric Railway Co.—The directors have declared a quarterly dividend on the capital stock (exclusive of the recent issue of new shares) at the rate of 12 per cent.

Russian Schuckert Co.—The accounts of this St. Petersburg company for 1911-12, after allocating £6,700 to depreciation, as against £6,600 in 1910-11, show net profits of £16,592, as compared with £15,070 in the previous year. A dividend at the rate of 5 per cent. has been declared, this contrasting with 4 per cent. in 1910-11. It is now proposed to increase the share capital from £200,000 to £300,000 by the issue of new shares at the price of 106 per cent.

CITY NOTES.

Capital Expansion in Germany.

The board of the Berlin-Hagen Accumulator Works Co. contemplate an increase of £200,000 in the ordinary share capital, thus raising it to £600,000. Although the present quotation for the shares exceeds 500 per cent., the directors have decided to grant a considerable bonus to the shareholders by offering them the new shares at par value. The company possesses practically a monopoly of the trade in secondary batteries by reason of its agreements with the large manufacturing firms, and the dividend paid in 1911 was at the rate of 25 per cent., as against 15 per cent. in the preceding year.

The Siemens-Schuckert Works, whose ordinary capital of £4,500,000 is jointly held by the Siemens & Halske Co. and the Elektrizitäts Gesellschaft vorm. Schuckert & Co., propose to make a fresh issue of £1,500,000 in 4½ per cent. obligations, which are to be taken over by a banking syndicate which has already applied for the admission of the loan on the Berlin Stock Exchange. Two loans, totalling £2,500,000, are at present in circulation, and the further emission will increase the amount to £4,000,000. In addition, the two proprietary companies have advanced £2,500,000 in the form of a 6½ per cent. non-terminable loan, so that the combined share and loan capital will soon amount to £11,000,000. No official statement has yet been issued regarding the purposes to which the loan is proposed to be devoted, and it is, therefore, assumed that the proceeds are intended to strengthen the financial resources of the company. At the same time, it has to be borne in mind that the company took over £425,000 of shares in the Bergmann Electricity Works Co. a few months ago at the price of 110 per cent.

The directors of the Allgemeine Elektrizitäts Gesellschaft announce that they have under consideration the question of proposing an increase of £1,250,000 in the ordinary share capital at the general meeting in November. Presumably, the new shares will participate in the dividend as from July 1st, 1912, and be offered to the shareholders in the ratio of one new share for seven existing shares at the price of 210 per cent., whilst the balance remaining will be disposed of for the account of the company. The augmentation of capital is intended to maintain the liquidity hitherto prevailing, notwithstanding the very considerable extension of the works and the growing volume of business. This announcement had been expected for some time past, and the realisation of the scheme will raise the total share capital to £7,750,000. The preferential right of subscription granted to shareholders represents £925,000, leaving £325,000 to be placed otherwise, and the total issue will produce over £2,500,000. It is calculated that the cash proceeds from the issue of shares since 1883 have yielded a premium of £4,250,000, inclusive of the impending emission, but leaving entirely out of consideration the large blocks of shares which have been exchanged for shares in other undertakings in the course of years. The ordinary capital expansion is illustrated by the following table :—

Year.	Ordinary share capital.	Price of issue.
1883	£250,000	—
1887	600,000	122 per cent.
1889	800,000	150 ,,
1889	1,000,000	165 ,,
1895	1,100,000	165 ,,
1896	1,250,000	175 ,,
1897	1,750,000	190 ,,
1897	2,350,000	—
1899	3,000,000	200 ,,
1904	4,300,000	—
1905	5,000,000	194½ ,,
1910	6,500,000	200 ,,
1912	7,750,000	210 ,,

The present price of the shares slightly exceeds 267 per cent. Apart from the ordinary shares the company has loan capital amounting to £4,000,000, of which £1,500,000 was issued last year, and the grand total represents the nominal sum of £11,750,000. During the past 12 months the company has entered upon numerous undertakings of various kinds, and the new issue of capital is presumably intended to provide funds so as to be ready for the future development of railways, overland central stations and other enterprises.

Dundee, Broughty Ferry and District Tramways Co., Ltd.—The profit for the year (including the sum brought forward from last year), after providing for interest on debenture stock, amounts to £5,471. From this there falls to be deducted the interim dividend on the preference shares for the half-year to January 31st, 1912, at the rate of 6 per cent. per annum, which absorbed £1,500, leaving a balance of £3,971. The directors propose to deal with this sum as follows :—Final dividend on preference shares, £1,500 ; to renewals fund, £600 ; to sinking fund for redemption of debenture stock, £600 ; to pay dividend on the ordinary shares at the rate of 2½ per cent. per annum, £718 ; and to carry forward to next account, £552. Receipts for the year show an increase of £735, and the expenditure an increase of £470.

Shawinigan Water and Power Co.—At a meeting on September 3rd the issue of $5,000,000 additional capital was authorised The capital stock is now $25,000,000.

German Electrical Companies.

The Kabelwerke Rheydt, after making provision for reserve and depreciation funds, proposes to pay 8 per cent. on the share capital of £250,000 for 1911-12. This result compares with a slight loss on the preceding year.

Körtings Elektrizitats Werke, A.G., of Berlin, realised net profits of £15,500 in 1911-12 on an ordinary share capital of £150,000, as compared with £14,700 in the preceding year, and a dividend of 8 per cent. has been declared, as against 7½ per cent. in 1910-11. This company owns and works various overland central stations whose business is constantly increasing, and the results are very satisfactory having regard to the class of stations in question.

The Isaria Zählerwerke, A.G., of Munich, report a considerable increase in the volume of trade in 1911-12, although the pressure of competition caused sale prices to further decline. The provision made for depreciation is £6,800, as compared with £5,600 in 1910-11, leaving net profits and balance forward of £15,300, as contrasted with £15,000. A dividend of 10 per cent. has been declared, this being the same rate as in 1910-11.

The accounts of *Brown, Boveri & Co.*, of Mannheim, show that the sum of £27,000 has been allocated to depreciation in 1911-12, as contrasted with £21,000 in the previous year, the net profits being returned at £21,700, as against £17,500 in 1910-11. A dividend of 5 per cent. has been declared on the share capital of £300,000, as compared with 4 per cent. in the former period. According to the directors' report, the considerable increase in the production was solely responsible for the better results, as the improvement in prices was only slight and was more than equalised by dearer raw materials and advances in wages. The largest share of the total output was again taken by steam turbines, which had a greater sale. The departments for electrical machinery and apparatus were also fully employed, mainly with plant for mines and ironworks and allied branches. Very favourable results were obtained with the company's system of main shaft winding installations, and many fresh orders were received. The recently introduced safety and governing apparatus had met with special recognition and led to the hope of considerable orders in the new year. As to the future prospects, the report states that the company entered the present financial year with a large stock of orders, which will provide full employment during the year.

The report for 1911-12 of the *Wolfram Lampen A.G., of Augsburg*, which has not paid any dividend since the undertaking was established in 1906, states that the company was compelled to make further reductions in prices in the second half of the year, in consequence of the action taken by several leading competitors, and trade competition has recently become aggravated, particularly in the export business. The introduction of drawn wolfram wire had also proved unfavourable to the company, as the working up of stocks bought at high prices, either resulted in a loss or yielded no profits. Employment was fairly satisfactory, and the turnover increased by 40 per cent., as compared with the previous year. The competition of the three principal firms with drawn-wire filaments had been met by the invention of a new lamp, which has not a drawn filament. It is claimed that the metallic-filament of this lamp when in constant use, is more durable than a drawn filament, although the manufacture of drawn wolfram filaments has also been undertaken, as it enables the cost of production to be considerably reduced. After placing the sum of £14,300 to depreciation in 1911-12, as compared with £11,500 in the preceding year, the accounts indicate a loss of £26,000, as against a loss of £4,200 in 1910-11. The reserve fund of £6,100 is drawn upon to meet a portion of the loss, leaving a large deficit to be carried forward. It is now proposed to reconstruct the company by reducing the share capital from £150,000 to £30,000, so as to extinguish the deficit and further provide for depreciation, and then to increase the capital to £60,000.

Stock Exchange Announcements.—The Committee has appointed Thursday, October 3rd, a special settling day in Empire District Electric Co. fully-paid scrip for $1,500,000 first mortgage 5 per cent. sinking fund gold bonds.

British Insulated and Helsby Cables, Ltd.—According to a financial daily the directors have declared an interim dividend at the rate of 8 per cent. per annum, less tax.

STOCKS AND SHARES.

Tuesday Evening.

Another wild outburst of buying of some of the Underground Railway stocks stands out as the prominent feature of the week in the electrical markets. Metropolitans have been especially conspicuous. The Metropolitan Electric Lighting group remains as "hard as nails," to speak colloquially. There is a good deal of business doing in one section and another, the pressure of a little monetary tightness in New York and London failing to affect prices to any appreciable extent.

Metropolitans, after rising no less than 6 since last week, reacted to 63, making a gain of 2 on balance, and this latest advance comes, of course, on the top of an earlier movement in the same direction. Indeed, the stock is 15 points higher than it was at one time this year. Rumour still attaches the company to one of its bigger brethren, which is supposed to be angling for control, the *quid pro quo* being reported as a 3½ or 4 per cent.

guaranteed dividend on the present Metropolitan stock. Some official notification is expected hourly, and the market is on the tip-toe of expectation for something of this sort. Districts have followed more leisurely, but the price is higher on the week. City and South London rose 2, this being another case in which rumours of absorption are playing an important part. Central London stocks are better, the Preferred being 2 higher at 85. Underground Electric Railways issues have come into further prominence, and long-sighted investors are buying the Company's £10 shares, while the Income bonds are being picked up by people with a speculative turn of mind, who look for a full dividend next year. There is a lively gamble going on in the "A" 1s. shares, and the price has risen to 15s. 9d.

The extraordinary developments of the London General Omnibus Company supply the motive power for these rises in Underground Electric shares, and it must be admitted that the strides made by the 'Bus Company have been nothing short of phenomenal.

There is a better tone also for Metropolitan Electric Trams and British Electric Traction issues. The Tramway Deferred shares are once more 5s. middle, and the demand for British Electric Tractions has extended to the 6 per cent. Preferred. Attention has been drawn to the 4½ per cent. Debenture of the Yorkshire West Riding Company, the return on which is nearly 5½ per cent., while the security is not at all bad. It is naturally a lock-up investment, not likely to move either up or down with any degree of rapidity. London United Tramways Debenture stock has lost a point.

The list of English electricity supply shares contains several rises, of which 30s. in City of London Ordinary is the principal. Speculative buying of these has wiped out the loss of the past fortnight, and vague reports are already being circulated again. County Ordinary at 11¾ *ex* dividend are 6s. 6d. higher. Metropolitans and Kensingtons rose ½, and the market is considerably harder than might appear from the quotations in the Official List. Judged from the list of bargains officially recorded, it might not be supposed that there was any interest being taken in this market; but, in point of fact, it is being keenly watched, and any shares that come in are readily taken. Meanwhile, proprietors are holding tenaciously to their shares, many of them, no doubt, in the expectation of something coming of the rumours which have begun to crystallise in regard to a linking-up scheme through the Metropolis. Probably there is nothing more in this idea than there has been for the past two years, but amalgamations are the fashion of the day. Fortunes have been made out of working agreements in the shipping and other markets just lately, and the words themselves have come to bear a magical meaning, to which the full charm of sentiment lends its weight.

The Telegraph department is quietly steady, with Great Northerns 10s. up, and Eastern Ordinary better to the same extent. Western s are also in request by reason of their good yield, but the Anglo-American descriptions are a trifle irregular. The demand for South American Telephone shares is unabated. Chile Telephones and United River Plate Telephones are both higher on the week. Reuters gained ⅛, being now 10½ middle, and the new shares are better at 5. Marconis, after wide fluctuations, show very little change, and National Telephone Deferred parted with 30s. of its previous substantial gain.

One of the new introductions is the Common stock of the Columbia Gas and Electric Company, the $100 fully-paid shares being quoted at 18½. The Company operates, not in Columbia, as might have been expected, but in West Virginia, Kentucky and Cincinnati, and its activities cover a wide scope. The shares can only be regarded as a thorough speculation. Their hopes of dividends lie in a big expansion of the present profits, which are, however, going ahead at a rapid rate. The Mexican group is inclined to be easier, both Mexican Light and Power and Mexico Tramways giving way in consequence of the unsatisfactory news with respect to the rebellion in the country. Mexican Electric Fives are 2½ down. Rio Trams, on the other hand, are better, and Sao Paulos recovered the dividend deducted last pay-day. Brisbane Tramway shares and stocks are stronger, but rather a feature is a fall of ⅜ in Madras Ordinary. Baltimore Gas and Electric Ordinary and Preferred continue to creep up, gains of 2 and 1 respectively occurring this week.

The Manufacturing division shows another rise of 10s. in India-Rubber shares, the expectation being that the Ordinary shares of the company will re-enter the dividend list at an early date. Telegraph Constructions and Henleys are both better. Rubber shares are a dull and somewhat disappointing market in consequence of the sagging of the price of the raw stuff. The rise in metals other than gold has brought about active dealings in the shares of all the mining companies concerned, and City promoters are busily searching Cornwall and Devonshire for likely tin mines. As usual in a rise, the prices of all the metals are being talked better, the "bulls" of lead being particularly hopeful.

Bromley (Kent) Electric Light and Power Co., Ltd.—The directors have declared an interim dividend at the rate of 4 per cent. per annum (2s. per share), less income-tax, on the ordinary shares for the half-year to June 30th.

Direct Spanish Telegraph Co., Ltd.—The board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent. per annum, free of income-tax, on the ordinary shares, both for the half-year ended June 30th, and payable on October 1st.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	Inc.
Aberdeen	Sept. 11	3,416	+ 196	16	24,548	— 175	14·4	..
Ayr	„ 14	610	— 30	17	7,668	+ 122	8	..
Bath	..	..	..	..	..	..	..	..
Birkenhead	..	..	..	..	..	..	..	..
Birmingham Corp.	„ 7	21,392	+3,406	23	243,020	+56,521	57·17	..
Blackburn	„ 11	2,447	— 135	24⅔	29,444	— 14	14·62	..
Blackpool Corp.	„ 12	6,413	— 360	..	50,589	+ 4,934	11·87	..
Blackpool-Fleetw'd	„ 14	3,412	— 15	10	18,468	— 1,019	8	..
Bournemouth	„ 11	4,953	+ 180	23⅔	48,075	+ 1,110	21·95	..
Bradford	„ 7	10,869	— 130	23	129,922	— 2,367	56	1·2
Brighton	„ 15	2,440	— 171	24	27,724	— 1,075	9·5	..
Bristol	„ 13	15,850	+1,185	..	256,169	+18,731	30·5	..
Brit. Elec. Trac. Co.								
Airdrie	„ 6	656	+ 199	36	10,655	+ 2,841	3·65	..
Barnsley	„ 6	397	+ 27	„	6,352	— 274	..	..
Barrow	„ 6	859	+ 55	„	13,937	+ 2,875	5·37	..
Devonport	„ 6	1,095	— 60	„	19,422	+ 1,487	8·85	..
Gateshead	„ 6	2,180	+ 50	„	37,191	— 165	11·25	..
Gravesend	„ 6	470	— 15	„	7,512	— 214	6·5	..
Greenock	„ 6	1,901	+ 192	„	29,236	+ 3,041	7·25	..
Hartlepool	..	..	..	..	..	..	..	..
Kidderminster	„ 6	277	— 19	„	4,425	+ 26	..	..
†Leamington	„ 6	441	— 69	„	6,884	+ 336	..	..
Merthyr	„ 6	440	+ 4	„	7,166	— 401	2·9	..
Metropolitan	„ 6	18,432	−1,441	„	318,018	+ 525	22	..
Middleton	„ 6	499	— 80	„	12,155	— 409	8·5	..
Mid.Joint Com'tee	„ 6	7,014	+ 274	„	117,165	+ 5,215	..	..
Oldham—Ashton	„ 6	1,240	+ 13	„	21,993	+ 1,305	9·18	..
Peterborough	„ 6	304	— 17	„	4,979	+ 312	5·81	..
Potteries	„ 6	3,999	+ 89	„	67,624	— 1,377	29	..
Rothesay	„ 6	829	+ 76	„	9,097	+ 307	2·75	..
Southport	„ 6	662	— 86	„	11,050	— 330	8·17	..
S. Metropolitan	„ 6	1,763	— 267	„	30,876	— 927	..	..
Swansea	„ 6	2,471	+ 17	„	41,499	+ 53	12·5	..
Tynemouth	„ 6	689	— 90	„	9,314	— 975	3·75	..
Weston-s-Mare	„ 6	654	— 252	„	5,763	— 1,218	3	..
†Worcester	„ 6	685	— 56	„	10,740	— 76	5·75	..
Wrexham	„ 6	3 6	+ 149	„	4,135	+ 484	..	..
Yorks. Wool. Dist.	„ 6	2,189	— 36	„	38,883	+ 878	17	..
Miscellaneous	„ 6	515	— 19	„	8,431	+ 86	..	..
Burnley	„ 14	3,199	+ 134	..	..	..	12 4	1
Burton-on-Trent	„ 15	534	— 42	24	6,642	— 4·8	6·6	..
†Bury	„ 8	1,270	— 70	23	30,512	— 800	22·5	..
†Cardiff	Aug. 24	2,600	+ 159	21	51,725	— 2,847	17·35	..
Chatham and Dist.	Sept. 12	1,794	— 210	37	31,670	— 371	14·98	..
Cork	„ 12	1.019	— 204	37	17.945	— 901	9·89	..
Croydon	„ 6	3,535	— 230	23	42,757	— 1,198	11·6	·75
†Darlington	„ 7	230	— 2	23	5,217	+ 41	4·87	..
Darwen	„ 13	587	— 12	24	6,799	+ 131	4·36	..
Dover	„ 7	610	— 83	23	6,222	— 469	4·75	..
Dublin	„ 13	12,270	— 86	..	86,490	— 9,837	54·25	..
East Ham	„ 14	2,120	— 108	24	25,805	— 411	7·87	..
†Exeter	..	..	..	..	..	..	..	..
Glasgow	„ 14	38 413	−2,313	37	2·1,942	— 4,669	98	..
Hastings	„ 16	2,765	— 3.7	..	..	..	19·3	..
Huddersfield	..	..	..	..	..	..	..	..
Hull	„ 14	5,925	+ 232	24	69,688	+ 526	13·5	−1
Ilkeston	„ 12	254	— 25	24	2,615	— 656	..	..
Ipswich	„ 7	1,053	— 90	23	11,115	— 173	10·5	..
Kilmarnock	„ 14	315	+ 4	17	2,943	— 226	4·25	..
Lancashire United	„ 11	2,969	— 54	39	49,527	— 521	39	..
Leeds	„ 14	15,671	+ 236	24	188,515	+ 5,290	112·7	..
Leicester	„ 14	5,030	— 1	37	93,901	+ 2,670	20	..
Leith	„ 14	1,317	— 22	17⅔	12,687	+ 70	8·72	..
Liverpool	„ 7	24,331	+1,369	35⅔	429,964	+19,454	117	1
†L.C.C.	„ 4	80,376	−6,135	..	992,191	−47,994	141·1	−·5
London United	„ 14	12,676	−1,573	..	235,639	−12,893	..	..
Lowestoft	„ 14	620	— 229	50	10,280	— 850	3·5	..
Manchester	„ 14	33,455	+ 737	24	404,758	+12,710	105	..
Newcastle	„ 14	8,693	+ 435	..	105,023	+ 733	31·3	..
†Newport	„ 7	743	+ 21	23	14.377	— 761	7·25	..
Oldham	„ 15	3,831	— 63	25	51,899	+ 2,735	23	..
Pontypridd	„ 14	900	+ 91	24	9,330	— 744	5·5	..
Portsmouth	„ 14	4,797	— 466	24	56,3·7	— 4,688	15·75	..
Preston	„ 11	1,709	+ 42	24	20,351	+ 911	10	..
Rotherham	„ 11	1,535	+ 179	23⅔	17,179	+ 985	12	..
Salford	„ 9	10,164	+ 314	23	118,006	+ 2,604	41	..
Sheffield	„ 17	13,448	+ 771	25	165,001	+ 5,471	40	..
Southampton	„ 11	2,721	— 135	23	30,895	— 107	11	..
Southend-on-Sea	Aug. 28	2,503	+ 213	22	19,749	+ 2,152	7	..
South Shields	Sept. 14	1,295	+ 33	24	15,567	— 211	10·25	..
Tyneside	„ 11	985	— 37	11	5,878	— 889	11	..
Wallasey	„ 14	2,269	— 108	25⅔	28,163	— 485	8·72	..
Walthamstow	„ 14	1,469	— 125	24	18,913	— 699	9	..
West Ham	„ 5	5 265	— 240	22⅔	60,801	— 2,215	16·45	1·2
Wolverhampton	„ 11	1,995	— 10	24	24,436	+ 249	13·75	..
Cen London Rly.	„ 14	9,251	+ 613	11	47,752	+ 434	6·78	·5
City & S. Lon. Rly.	„ 15	5 597	— 691	11	31,274	— 2,338	7·25	..
Dublin-Lucan Rly.	„ 14	341	— 8	11	1,790	— 138	7	..
Gt. N. and City Rly.	„ 7	1,318	— 19	10	13,340	+ 8	5·5	..
L'pool Overh'd Rly.	„ 15	3,285	+ 19	..	18,682	+ 1,630	6·6	..
Llandudno-Col. Bay	„ 13	1,384	+ 152	41·5	13,739	+ 6 8	6·5	..
Lond. Elec. Ry. Co.	„ 11	24,005	+ 715	..	132,100	+ 4,695	21·24	..
Mersey Railway	„ 14	3 895	+ 572	11	22 4 9	+ 2,721	4·5	..
Metropolitan Rly.	„ 15	32 880	+ 531	11	182,837	+ 5,014	45·74	..
Met. District Rly.	„ 14	23 918	+2,312	..	124,768	+11,578	25	..
Anglo-Argentine	„ 16	104,282	+3,442	37	1,871,653	+67 255	..	..
§Auckland	Aug. 2	18 353	+ 2 154	5	21,828	+ 5,659	23·31	..
Bombay (B.E.T.)	„ 22	4,782	+ 106	33	101 051	+ 4,708	..	..
§Brisbane	Aug.	27,680	+3,030	8	158,394	— 5,126	..	..
Brit. Columbia Rly.	..	..	..	..	..	..	..	..
Calcutta	Sept. 14	8,697	+ 651	..	..	..	..	..
Cape Electric T.Ld.	..	..	..	..	..	..	..	..
§Kalgoorlie, W.A.	Aug.	8,887	..	..	25,587	..	20·5	..
§Lisbon	..	..	..	..	..	..	..	..
Madras	Sept. 15	1,785	+1,638	..	28,855	+ 3,165	13·5	·6
§Montevideo	Aug.	26,249	+2 234	10	290,107	+39,834	..	..
Perth (W.A.)	Sept. 13	3 664	+ 525	..	68,672	+ 9,746	29	..

* Compared with the corresponding period of 1911. † One week only.
‡ Includes horse, steam and other receipts. § One month.

SHARE LIST OF ELECTRICAL COMPANIES.

ENGLISH ELECTRICITY SUPPLY AND POWER COMPANIES.

NAME.	Stock or Share.	Dividends for 1910.	Dividends for 1911.	Closing Quotations Sept. 17th.	Rise + or Fall —	Present Yield p.c. £ s. d.
Bournemouth & Poole, Ord.	10	5½	5½	9⅞ — 10⅛	..	5 2 4
Do. 4½ % Pref.	10	4½	4½	8⅞ — 9⅛	..	4 12 4
Do. Second 6 % Pref.	10	6	6	10¼ — 10½	..	5 11 7
Do. 4½ % Deb. Stock	Stock	4½	4½	98 —100	..	4 10 0
Brompton & Kensington, Ord.	5	10	10†	8⅝ — 9⅛	..	5 9 7
Do. 7 % Cum. Pref.	5	7	7	7⅞ — 8¼	..	4 4 10
Central Electric Supply, 4 % Guar. Deb.	100	4	4	97 —100	..	4 0 0
Charing Cross, West End & City	5	5	5	4⅞ — 5⅜	+ ⅛	4 13 0
Do. 4½ % Cum. Pref.	5	4½	4½	4⅜ — 4⅝	+ ⅛	4 14 9
Do. "City Undertaking" 4½ % Cum. Pref.	5	4½	4½	8¾ — 4½	..	5 6 0
Do. Do. 4 % Deb.	100	4	4	94 — 96	..	4 3 4
Chelsea, Ord.	5	5	5	4⅜ — 5	..	5 0 0
Do. 4½ % Deb.	Stock	4½	4½	98 —101	..	4 9 1
City of London, Ord.	10	7	8	17½ — 19	+1½	4 4 3
Do. 6 % Cum. Pref.	10	6	6	12 — 13½	..	4 9 0
Do. 5 % Deb.	Stock	5	5	118 —122	..	4 2 0
Do. 4½ % Second Deb.	100	4½	4½	99 —102	..	4 8 8
County of London, Ord.	10	5	6	11⅛ — 12 xd	6/6	5 0 0
Do. 6 % Pref.	10	6	6	11⅝ — 12⅛ xd	..	4 19 0
Do. 4½ % Deb.	Stock	4½	4½	106 —108	..	4 3 4
Do. 4½ % Second Deb.	Stock	4½	4½	100 —103	..	4 8 3
Edmundson's, Ord.	5	Nil	Nil	7/16 — 11/16	..	Nil
Do. 6 % Cum. Pref.	5	Nil	Nil	3— 3½	..	Nil
Do. 4½ % First Mort. Deb.	100	4½	4½	84 — 87	..	5 3 6
Folkestone	5	6	6	4⅞ — 5⅛	..	5 14 3
Do. 5 % Cum. Pref.	5	5	5	4⅜ — 5⅛	..	4 15 3
Do. 4½ % First Deb.	100	4½	4½	92 — 95	..	4 14 9
Hove	5	9	9	7½ — 8	..	5 12 6
Kensington & Knightsbridge, Ord	5	9	9	7½ — 8	+ ¼	5 12 6
Do. 4 % Deb.	Stock	4	4	90 — 93	..	4 6 0
Kent Elec. Power, 4½ % Deb.	Stock	4½	4½	78 — 82	..	5 9 9
London Electric, Ord.	8	2	2½	1⅛ — 2	+ ⅛	3 15 0
Do. 6 % Pref.	5	6	6	4⅜ — 5½	..	5 14 8
Do. 4 % First Mort. Deb.	Stock	4	4	90 — 93	..	4 6 0
Metropolitan	5	5	4	3⅜ — 4⅛	+ ⅛	4 14 2
Do. 4½ % Cum. Pref.	5	4½	4½	4¼ — 4⅝	..	4 17 4
Do. 4½ % First Mort. Deb.	Stock	4½	4½	99 —102	..	4 8 3
Do. 3½ % Mort. Deb.	Stock	3½	3½	86 — 88	..	3 19 7
Midland Electric Corporation 4½ % First Mort. Deb.	100	4½	4½	97½ — 99½	..	4 10 6
Newcastle-on-Tyne 5 % Pref., Non-Cum.	5	5	5	4⅜ — 4⅞	..	5 2 7
North Metropolitan Power Supply, 5 % Mortgages (Red.)	100	5	5	101 —104	..	4 16 2
Notting Hill, 6 % Non-Cum. Pref.	10	..	6	10 — 11	..	5 9 1
Oxford	5	7½	7½	5⅜ — 6½ xd	..	5 16 0
St. James' and Pall Mall, Ord.	5	10	10	8¾ — 9⅛	..	5 5 3
Do. 7 % Pref.	5	7	7	6¾ — 7⅛	..	4 16 7
Do. 3½ % Deb.	100	3½	3½	85 — 88	+2	3 19 7
Smithfield Markets, Ord.	5	Nil	2	1⅝ — 1⅞	..	..
South London, Ord.	4	5	5	3 — 3½	..	5 14 3
Do. 5 % First Mort. Deb.	100	5	5	98 —101	..	4 19 0
South Metropolitan, 7 % Pref.	1	7	7	1⅛ — 1¼	..	5 12 0
Do. 4½ % First Deb. Stock	100	4½	4½	97 —100	..	4 10 0
Urban, Ord.	£3	5	..	1/4 — 3/4	..	..
Do. 5 % Cum. Pref.	5	5	2	2½ — 3	..	..
Do. 4½ % First Mort. Deb.	100	4½	4½	80⅝ — 83½	..	5 1 8
Westminster, Ord.	5	10	10	8¾ — 9¼	..	5 8 1
Do. 4½ % Cum. Pref.	5	4½	4½	5 — 5⅛	..	4 3 0

COLONIAL AND FOREIGN ELECTRICITY SUPPLY AND POWER.

Adelaide, 6 % Pref.	5	6	6	5⅛ — 5¾	..	5 4 4
Calcutta, Ord.	5	8½	8½	7⅛ — 8	..	5 6 3
Do. 5 % Pref.	5	5	5	4⅛ — 5 3/16	..	4 16 5
Calgary Power, 1st Mort. Bds.	100	5	5	95¾ — 97½	..	5 2 7
Canadian Gen. El. Com.	$100	7	7†	114 —119	..	5 17 8
Do. 7 % Pref.	$100	7	7	121 —125	..	5 12 0
Cordoba Lt., Power and T., Ord.	1	3	3†	1⅞ — 1 15/16	..	3 4 0
Do. 5 % Deb.	100	5	..	96 — 99	+1	5 1 0
Elec. Lt. and P. of Cochabamba, 6 % Bonds	100	6	6	92 — 94	..	6 7 8
Elec. Supply Victoria, 5 % 1st Mort. Deb.	100	5	5	81 — 84	..	5 19 1
Elec. Dev. Ontario, 5 % 1st Mort. Bonds	$500	5	5	95⅛ — 97½	— ⅛	5 2 7
Kalgoorlie Elec. P. and L., Ord.	10/-	Nil	..	1/16 — 3/32	+ 1/16	Nil
Do. 6 % Pref.	1	6	6	5/8 — 11/16	..	8 6 0
Kaministiquia Power, 5 % G. Bs.	$500	5	5	104 —106	..	4 14 4
Madras, Ord.	£5	..	..	1½ — 2	— ⅛	..
Melbourne, 5 % 1st Mort. Deb.	100	5	5	102 —105	..	4 15 3
Mexican El. Lt., 5 % 1st M. Bds.	..	5	5	86½ — 88½	—2½	5 13 0
Mexican Lt. & Power, Common	$100	4	4	95 — 98	—1	4 0 10
Do. 7 % Cum. Pref.	$100	7	7	109 —112	..	6 5 0
Do. 5 % 1st Mort. Gold Bds.	..	5	5	96 — 98	— ½	5 2 0
Monterey Rly. Light & Power, 5 % 1st Mort. Deb.	100	5	5	87 — 89	..	5 12 4
Montreal, Lt., H. and Power	$100	7	8	232 —237	..	3 7 6
Northern, Lt., Power and Coal, 5 % 1st Mort. Bonds	$500	5	5	39 — 42	..	..
River Plate, Ord.	Stock	10	10	240 —250	..	4 0 0
Do. 6 % Non-Cum. Pref.	Do.	6	6	109 —114	..	5 5 8
Do. 5 % Deb. Stock	Do.	5	5	101 —103	..	4 17 1
Roy. Elec. Co., Montreal, 4½ % 1st Mort. Deb.	100	4½	4½	99 —101	..	4 9 1
Shawinigan Water, Capital	$100	4	5†	152 —157	+1	3 3 8
Do. 5 % Con. 1st Mort. Bonds	$500	5	5	108 —110	+ ½	4 11 0
Do. 4½ % Per. Deb.	Stock	4½	4½	104 —106	..	4 5 0
Toronto Power, 4½ % Deb.	Do.	4½	4½	99½ — 101½	..	4 8 8
Vera Cruz Lt., P. and T., 5 % 1st Mort. Deb.	100	5	5	93 — 95	..	5 5 3
Victoria Falls Power, Pref.	1	Nil	11¼d.	31/32 — 1 1/32	..	..
West Kootenay Power and Lt., 1st Mort. 6 % Gold	100	6	6	103 —105	..	5 14 3

TELEGRAPH AND TELEPHONE COMPANIES.

Amazon Telegraph	10	Nil	4†	7⅛ — 7⅜	..	5 8 3
Do. 5 % Deb. Red.	Stock	5	5	95½ — 97½	..	5 2 7
American Telep. & Teleg., Cap.	$100	8	8†	147 —149	— ½	5 7 5
Do. Collat. Trust	$1000	4	4	93½ — 95½	..	4 3 9
Anglo-American Telegraph	Stock	3	3	67½ — 69½	..	5 7 11
Do. 6 % Pref.	Do.	6	6	113½ — 114½	+ ½	5 4 10
Do. Def.	Do.	30/-	30/-	26½ — 26⅞	+ ⅛	5 12 2
Anglo-Portuguese Tel., 5 % Mort. Deb.	100	5	5	102 —104	..	4 16 2
Chili Telephone	5	7	..	7⅜ — 7⅝	+ ⅛	4 8 11
Commercial Cable, Stlg. 4 % Deb.	Stock	4	4	83½ — 85½	..	4 13 7
Cuba Telegraph	10	6	6†	9½ — 10½	..	5 14 3
Do. 10 % Pref.	10	10	10	16½ — 17½	..	5 14 3
Direct Spanish Telegraph, Ord.	5	4	4†	3½ — 3¾	..	5 6 8
Do. 10 % Cum. Pref.	5	10	10	6¾ — 7¼	— ⅛	6 17 11
Direct United States Cable	10	4½	5	7½ — 8	..	6 5 0
Direct W. India Cable, 4½ % Reg. Deb.	100	4½	4½	98 —100	..	4 10 0
Eastern Telegraph, Ord. Stock	Stock	7	7	130 —133	+ ½	5 5 3
Do. 3½ % Pref. Stock	Do.	3½	3½	78 — 80	..	4 7 6
Do. 4 % Mort. Deb.	Do.	4	4	99½ — 101½	..	3 18 10
Eastern Extension	10	7	7	18⅜ — 13⅝	..	5 2 9
Do. 4 % Deb.	Stock	4	4	98½ — 100½	..	3 19 7
East and S. Africa Tel. 4 % Mt. Db. Mauritius Sub.	25	4	4	97½ — 100½	..	3 19 7
Globe Telegraph and Trust	10	5⅞	6†	11 — 11½	..	5 4 4
Do. 6 % Pref.	10	6	6	12⅜ — 13½	..	4 10 7
Great Northern Telegraph	10	18	18	28¾ — 29¾	+ ½	6 1 0
Indo-European Telegraph	25	18	18	57 — 59	..	5 3 5
Mackay Companies Common	$100	5	5	87 — 91 xd	—1½	5 9 11
Do. 4 % Cum. Pref.	$100	4	4	68 — 70 xd	— ½	5 14 4
Marconi's Wireless Telegraph	1	5	20	5 7/16 — 5 9/16	— 1/16	3 11 2
Do. 7 % Cum. Partic. Pref.	1	16	17	4¾ — 5	..	3 8 0
Monte Video Telephone, Ord.	1	6	6	1⅞ — 1⅝	..	5 6 3
Do. 5 % Pref.	1	5	5	13/16 — 7/8	..	5 6 8
National Telephone Def.	Stock	6	6	155 —157	—1½	..
New York Telep., 4½ % Gen. Bnds.	100	4½	4½	100¾ — 101¾	..	4 8 8
Oriental Telep. and Elec.	1	8	8	1 1/16 — 1 1/8	..	4 8 2
Do. 6 % Cum. Pref.	1	6	6	1⅝ — 1 11/16	..	4 18 5
Do. 4 % Red. Deb.	Stock	4	4	88 — 90	..	4 9
Pacific and European Tel., 4 % Guar. Debs.	Do.	4	4	98 —100	..	8 18
Reuter's	8	5	5†	10¼ — 10⅜	+ ⅛	3 14 5
Submarine Cables Trust	Cert.	6	6	127 —130	..	4 12 4
Telephone Co. of Egypt, 4½ % Deb. Red.	Stock	4½	4½	99½ — 101½	..	4 8 8
United River Plate Telephone	5	8	8	7⅜ — 7⅝	+ ⅛	5 4 11
Do. 5 % Cum. Pref.	5	5	5	5⅜ — 5⅝	..	4 8 11
West Coast of America	2½	2½	2½	1 11/16 — 1 13/16	..	3 18 5
Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4	4	96 — 99	..	4 0 10
West India and Panama Teleg.	10	1½	½	3½ — 3⅝	— ⅛	..
Do. 6 % Cum. 1st Pref.	10	6	6	10⅜ — 10⅝	..	5 11 7
Do. 6 % Cum. 2nd Pref.	10	6	6	9⅝ — 10⅜	..	5 17 0
Do. 5 % Debs.	100	5	5	100⅜ — 102⅜	..	4 17 7
Western Telegraph, Ltd.	10	7	7	13¾ — 13⅞	+ ¼	5 1 10
Do. 4 % Deb.	Stock	4	4	96 — 98	—1	4 1 8
Western Union 4½ % Fdg. Bonds	$1000	4½	4½	100 —103	..	4 7 5

* Unless otherwise stated, all shares are fully paid. † Interim dividend.

Continued on next page.

SHARE LIST OF ELECTRICAL COMPANIES.—(*Continued.*)

ELECTRIC RAILWAYS AND TRAMWAYS.—HOME.

NAME.	Stock or Share.	Dividends for 1910.	Dividends for 1911.	Closing Quotations Sept. 17th.	Rise + or Fall —	Present Yield £ s. d.
	*					
Bath Trams, Pref. Ord.	1	Nil	Nil	⅜ — ⅝	..	Nil
Do. 5 % Pref.	1	5	5	1 1/16 — 1 1/8	..	4 8 1
Do. 4½ % Deb.	100	4½	4½	78 — 83	..	5 8 5
Brit. Elec. Trac., 6 % Pref.	100	..	..	12 — 14	+1	..
Do. Do. Deferred	100	..	..	6 — 8	..	..
Do. Do. 6 % Cum. Pr'f.	100	..	6	89 — 92	..	6 10 5
Do. 7 % Non-Cum. Pr'f.	100	..	..	38 — 41	+1	..
Do. 5 % Perp. Deb.	100	5	5	98 —101	..	4 19 0
Do. 4½ % 2nd Deb.	100	4½	4½	80 — 84	..	5 7 2
Central London Railway, Ord.	100	3	3	77 — 79	+1	3 15 11
Do. Pref.	100	4	4	84 — 86	+2	4 13 0
Do. Def.	100	2	2	77 — 79	+1	2 10 8
Do. 4 % Deb.	100	4	4	100 —102	..	3 18 5
City & South London, Ord.	100	1⅝	1⅝	39½ — 40½	+2	3 7 11
Do. 5 % Pref., 1891	100	5	5	106 —108	..	4 12 7
Do. Do. 1896	100	5	5	103 —105	..	4 15 3
Do. Do. 1901	100	5	5	103 —105	..	4 15 3
Do. Do. 1908	100	5	5	102 —104	..	4 16 2
Do. 4 % Deb.	100	4	4	99 —101	..	3 19 3
Dublin United Trams, 6 % Pref.	10	6	6	10½ — 11½	..	5 2 2
Great Northern & City, Pr'f. Ord	10	Nil	..	2 — 2¼	..	Nil
Hastings Trams, 6 % Pref.	1	Nil	6	⅜ — ½	..	8 0 0
Do. 4½ % Deb.	100	4½	4½	71 — 76	..	5 18 5
Isle of Thanet Trams, 5 % Pref.	5	2½	2½	2⅛ — 2⅜	..	4 11 0
Do. 4 % Deb.	100	4	4	75 — 80	..	5 0 0
Lancashire United, 5 % Deb.	100	5	5	81 — 83	..	6 0 6
London Elec. Railw'ys, 4 % Deb.	100	4	4	95 — 97	..	4 2 6
London United Trams, 5 % Pref.	10	Nil	..	4½ — 5½	..	..
Do. 4 % Deb.	100	4	4	71 — 75	−1	5 6 8

NAME.	Stock or Share.	Dividends for 1910.	Dividends for 1911.	Closing Quotations Sept. 17th.	Rise + or Fall —	Present Yield £ s. d.
	*					
Metropolitan Railway Consol.	100	1⅜	1½	62⅜ — 63½	+2	2 11 5
Do. Surplus Lands	100	2½	2½	64 — 66	..	4 3 4
Do. 5½ % Deb.	100	5½	5½	87 — 89	..	3 16 11
Do. 5½ % Pref.	100	5½	5½	85 — 87	..	4 0 ..
Do. 5½ % Con. Pref.	100	5½	5½	84 — 86	..	4 1 5
Metropolitan District Ord.	100	Nil	Nil	42½ — 43	+1	Nil
Do. 6 % Deb.	100	6	6	141 —143	..	4 4 0
Do. 4 % Deb.	100	4	4	94 — 96	..	4 3 4
Do. 4 % Prior Lien	100	4	4	99 —101	..	3 19 3
Do. 4½ % First Pref.	100	3⅞	4½	89 — 91	..	4 19 0
Do. 5½ % Gtd.	100	5½	5½	75 — 77	..	4 11 0
Metropolitan Elec. Trams, Ord.	1	5½	6	1 3/32 — 1 5/32	+1/32	5 1 2
Do. Def.	1	Nil	..	3/32 — 5/32	+3/32	Nil
Do. 5 % Pref.	1	5	5	1/16 — 1/8	..	5 6 8
Do. 4½ % Deb.	100	4½	4½	97 — 99	+1	4 16 11
Do. 5 % Deb.	100	5	5	100 —103	..	4 17 1
Potteries, Ord.	1	2	..	3/32 — 7/32	..	..
Do. 5 % Pref.	1	5	5	3/32 — 5/32	..	6 19 0
Do. 4½ % Deb.	100	4½	4½	87 — 90	..	5 0 0
South Metro. Trams, 6 % Pref.	1	6	..	1/16 — 1/8	..	7 7 8
Do. 4 % Deb.	100	4	4	70 — 75	..	5 6 8
Underground Elec. Railways	10	..	..	4⅛ — 4⅜	+ ⅛	Nil
Do. "A"	1/-	..	..	3/16 — 1/4	+ 1/16	..
Do. 4½ % Bonds	100	4½	4½	99 —101	..	4 9 1
Do. 6 % Income	100	1	1½†	90 — 92	+ 1	..
Yorkshire (West Riding), Ord.	5	Nil	..	⅛ — ¼	..	Nil
Do. 6 % Pref.	5	Nil	3	2⅝ — 3⅛	..	4 9 0
Do. 4½ % Deb.	100	4½	4½	79 — 83	..	5 8 5

ELECTRICAL RAILWAYS AND TRAMWAYS.—COLONIAL AND FOREIGN.

Anglo-Arg. Trams, 1st Pref.	5	5	5½	5⅛ — 5⅜	..	5 2 4
Do. 2nd Pref.	5	5	5½	4 7/16 — 5⅛	— 1/16	5 7 4
Do. 4 % Deb.	100	4	4	93½ — 95	..	4 4 3
Do. 4½ % Deb.	100	4½	4½	100 —102	..	4 8 3
Do. 5 % Deb.	100	5	5	101 —103	..	4 17 1
Auckland Trams, 5 % Deb.	100	5	5	103 —105	..	4 15 3
Bombay Elec. S. & Trams, Pref.	10	6	6	11¼ — 12	..	5 0 0
Do. 4½ % Deb.	100	4½	4½	97 — 99	..	4 10 11
Do. 5 % 2nd Deb.	100	5	5	98 —100	+1	5 0 0
Brisbane Trams Invt., Ord.	5	8	8	7⅞ — 7 15/16	+ ⅛	5 4 11
Do. 5 % Pref.	5	5	5	5 — 5 1/16	+ ⅛	4 13 0
Do. 4½ % Deb.	100	4½	4½	100½ —103½	..	4 7 0
B. Columbia Elec. Rly., Def.	100	8	8	143 —148	..	5 8 1
Do. Pref. Ord.	100	6	6	120 —125	+1	4 16 0
Do. 5 % Pref.	100	5	5	109 —112	..	4 9 1
Do. 4½ % 1st Mort. Deb.	40	4½	4½	99½ —102½	..	4 7 10
Do. 4½ % Vancouver Deb.	100	4½	4½	103 —105	..	4 5 9
Do. 4½ % Con. Deb.	100	4½	4½	101 —103 xd	..	4 7 5
Calcutta Trams, Ord.	8	6	7	6⅛ — 6⅝	..	5 5 8
Do. 5 % Pref.	5	5	5	4 15/16 — 5 1/16	..	4 16 5
Do. 4½ % Deb.	100	4½	4½	99 —102	..	4 8 3
Cape Electric Trams	1	Nil	2½†	⅝ — ¾	..	..
City Buenos Aires Trams (1904)	5	5	5	5⅛ — 5⅜	..	4 6 11
Do. 4 % Deb.	100	5	5	99 —102	..	4 18 0
Colombo Elec. Tr. & Lt., 5 % Deb.	100	5	5	95 — 99	..	5 1 0
Havana Elec. Rly., 5 % Bonds	$1000	5	5	99 —103	..	4 17 1
Kalgoorlie Elec. Trams	1	Nil	..	3/16 — 5/16	..	Nil
Do. 5 % A Deb.	100	5	5	86 — 91	..	5 10 0
Do. 6 % B Deb.	100	5	3	35 — 43	..	6 19 6

La Plata Elec. Trms, Ord.	1	..	..	⅜ — ½	..	..
Do. Pref.	1	6	6	29/32 — 1	..	6 0 0
Lisbon Elec. Trams, Ord.	1	5½	6	1 1/16 — 1 5/16	+ 1/16	4 11 5
Do. 6 % Pref.	1	6	6	1 — 1 1/8	..	4 16 0
Do. 5 % Deb.	100	5	5	93 — 97	..	5 3 1
Madras Elec. Tr. (1904), Deb.	100	5	5	100 —102	..	4 18 0
Manaos Trams & Lt., 1st Deb.	100	5	5	90 — 93	..	5 7 6
Manila Elec. R. and Ltg., Bonds	$1000	5	5	100½ —102½	..	4 17 7
Mexico Trams Com.	$100	7	7	126 —129	−1	5 8 6
Do. Gen. Con. 5 % Bonds	..	5	5	98½ —100½	— ½	4 19 6
Do. 6 % Bonds	100	6	6	102½ —104½	— ½	5 14 10
Para Elec. Rlys. & Lt., Ord.	5	10	10	7⅜ — 7½	..	6 7 0
Do. 6 % Pref.	5	6	6	5 — 5½	..	5 9 1
Do. 5 % 1st Deb.	100	5	5	100½ —102½	..	4 17 6
Perth (W.A.) Elec. Tr., Ord.	1	2½	..	1⅛ — 1⅜	+ 1/32	1 16 4
Do. 5 % 1st. Deb.	100	5	5	99 —102	..	4 18 0
Rangoon El. Tr. & Sup., Pref.	5	6	6	5½ — 5⅞	..	5 4 4
Do. 4½ % 1st Deb.	100	4½	4½	97 — 99	..	4 11 0
Rio de Janeiro Trams	$100	4½	5†	152 —154	+1	3 4 11
Do. 1st Mort. 5 % Bonds	..	5	5	103½ —104½	+ ½	4 15 11
Do. 5 % Mort. Bonds	100	5	5	101 —102	+ ½	4 18 0
Sao Paulo Tram, Lt. and P.	$100	10	10†	261 —266	..	3 15 2
Do. 5 % 1st Deb.	$500	5	5	104½ —106½	..	4 14 0
Singapore Trams, 5 % Deb.	100	5	5	84 — 87	..	5 15 0
Southern El. Tr. B.A., 5 % Deb.	100	5	5	96 — 98	..	5 2 0
Un. Elec. Trams Monte Video	5	6	7	5⅝ — 6⅛	..	5 14 3
Do. 6 % Pref.	5	6	6	4⅝ — 5⅛	..	5 11 7
Do. 5 % 1st Deb.	100	5	5	101 —104	..	4 16 2
Winnipeg Elec. Rly., 4½ % Deb.	100	4½	4½	101½ —103½ xd	..	4 7 0

MANUFACTURING COMPANIES.

Aron, Ord.	1	Nil	6	⅜ — ½	..	8 0 0
Do. 6 % Pref.	1	9	6	1 1/16 — 1 1/8	..	7 7 8
Babcock & Wilcox	1	26	28	3 1/16 — 3 3/16	+ 1/16	4 2 10
Do. Pref.	1	6	6	1 5/16 — 1 3/8	..	3 16 10
British Aluminium, Ord.	1	..	..	1 1/16 — 1 1/8	..	..
Do. 6 % Cum. Pref.	1	..	..	⅛ — ¼	..	..
Do. 5 % Prior Lien Debs.	100	5	5	93 — 96	..	5 4 2
Do. Deb. Stk.	100	5	5	85 — 88	..	5 13 8
B.I. & Helsby Cables	5	10	10	7⅞ — 8⅛	..	6 1 3
Do. Pref.	5	6	6	5⅞ — 6⅛	..	4 14 1
Do. Deb.	100	4½	4½	102 —104	..	4 6 7
British Thomson-Houston, Deb.	100	4½	4½	94 — 96	..	4 13 9
British Westinghouse, Pref.	3	Nil	..	3/16 — 3/8	..	Nil
Do. Deb.	100	4	4	60 — 63	..	6 7 0
Do. 6 % Prior Lien	100	6	6	102 —105	..	5 14 3
Browett, Lindley, Ord.	1	Nil	..	2/- —3/-	..	Nil
Do. Pref.	1	Nil	..	4/6 —5/-	..	Nil
Brush, 7 % Pref.	2	Nil	..	0 — ½	..	Nil
Do. 5 % Prior Lien Deb.	100	5	5	75 — 80	..	6 6 5 0
Do. 4½ % Deb.	100	4½	4½	50 — 55	..	8 3 8
Do. 4½ % Second Deb.	100	4½	4½	35 — 40	..	11 5 0
Callender's Cable	5	15	10†	10½ — 11	..	6 16 4
Do. Pref.	5	5	5	4⅜ — 5⅛	..	4 17 7
Do. Deb.	100	4½	4½	99½ —101½	— ½	4 8 8
Castner-Kellner	1	17½	20	3⅜ — 3¾	..	5 3 3
Do. Deb.	100	4½	4½	102 —105	..	4 5 9

Crompton & Co.	8	Nil	Nil	½ — ⅝	..	Nil
Do. Deb.	100	5	5	56 — 66	..	7 11 6
Dick, Kerr	1	5	5	⅜ — ⅞	..	5 14 3
Do. Pref.	1	6	6	1 — 1⅛	..	5 6 8
Do. Deb.	100	4½	4½	97 —100	..	4 10 0
Edison & Swan, A, £3 paid	5	Nil	..	9/16 — 13/16	..	Nil
Do. fully paid	5	Nil	..	1 5/16 — 2 1/16	..	Nil
Do. 4 % Deb.	100	4	4	64 — 68	..	5 17 8
Do. 5 % Second Deb.	100	5	5	74 — 77	..	6 9 10
Electric Construction	2	2½	3⅜	1 — 1	..	7 10 0
Do. Pref.	2	7	7	1⅝ — 2	..	7 0 0
Greenwood & Batley, Pref.	10	7	7	7½ — 8	..	8 5 8
Do. Deb.	100	6	6	92 — 94	..	5 4 2
General Electric, Pref.	10	6	6	10 — 11	..	4 10 11
Do. Deb.	100	4	4	92 — 97	..	4 2 6
Henley's, Ord.	5	15	10†	12½ — 13	+ ½	5 15 5
Do. Pref.	5	4½	4½	4⅜ — 5	..	4 10 0
Do. Deb.	100	4½	4½	102 —104	..	4 6 7
India-Rubber, G. & T.	10	10	..	11½ — 12½	+ ½	..
Do. Pref.	10	5	5	9½ — 10½	..	4 17 7
Telegraph Construction	12	20	10†	34 — 36	+ ½	6 13 4
Do. Deb.	100	4	4	97 — 99	..	4 0 10
Willans & Robinson	1	Nil	..	⅜ — ½	..	Nil
Do. Pref.	5	Nil	..	½ — 1	..	Nil
Do. Deb.	100	4	4	58 — 60	..	6 13 4

* Unless otherwise stated, all shares are fully paid. † Interim dividend.

Bank rate of Discount 4 per cent., August 29th, 1912.

CHARACTERISTICS OF METAL FILAMENTS.

By DANIEL H. OGLEY, B.Eng., Royal Technical College, Salford.

It has long been known that for a given change in pressure the percentage variation in candle-power of a carbon lamp was much greater than that of an equally rated metal lamp.

The question naturally arises as to the extent of the variations, and during an extended series of tests on a number of the most modern metal-filament lamps on the market, the following figures were arrived at.

The first relation analysed was that between power consumption and impressed voltage. Steinmetz, testing a single lamp, stated that the power consumption varied as the 1·6th power of the voltage, and so followed a law analogous to that of the hysteresis loss in iron. In the latter case the power lost varies as the 1·6th power of the induction, or—

$$w \propto \beta^{1.6}.$$

In the lamp case—

$$w \propto \text{volts}^{1.6},$$

or

$$w = k v^{1.6},$$

when w = power in watts; k = constant; v = impressed volts.

The results of the tests on four modern lamps are as under :—

LAMP I.

Test.	Candle-power.	Volts.	Amperes.	Watts.	Watts calculated.	Diff.
1	8·2	90	·15	13·5	13·49	—
2	10·23	95	·155	14·7	14·71	—
3	12·6	100	·16	16	15·85	− ·9 %
4	14·24	105	·166	17·4	17·28	− ·7 %
5	16·7	110	·169	18·6	18·60	—
6	19·97	115	·174	20	19·97	—
7	24·46	120	·179	21·5	21·38	− ·5 %

Power characteristic.—Watts = ·01008 volt$^{1.6}$.
Lamp.—Osram, 110 volts, 17 watts.

LAMP II.

Test.	c.p.	Volts.	Amperes.	Watts.	Watts calculated.	Diff.
1	10·1	100	·14	14	13·84	− 1·1 %
2	11·6	105	·144	15·1	14·96	− ·9 %
3	14·5	110	·147	16·2	16·12	− ·5 %
4	16·18	115	·15	17·3	17·3	—
5	19·7	120	·154	18·5	18·52	+ ·1 %

Power characteristic.—Watts = ·00873 volt$^{1.6}$.
Lamp.—A.E.G., 110 volts, 16 c.p.

LAMP III.

Test.	c.p.	Volts.	Amperes.	Watts.	Watts calculated.	Diff.
1	5·58	85	·17	14·4	14·47	+ ·5 %
2	7·1	90	·178	16	15·87	− ·8 %
3	9·07	95	·182	17·3	17·3	—
4	11·2	100	·188	18·8	18·78	− ·1 %
5	13·46	105	·194	20·4	20·31	− ·4 %
6	16·5	110	·2	22	21·9	− ·4 %
7	19·56	115	·205	23·6	23·5	− ·4 %
8	22	120	·208	25	25·12	+ ·4 %

Power characteristic.—Watts = ·01185 volt$^{1.6}$.
Lamp.—Brimsdown, 110 volts, 16 c.p.

LAMP IV.

Test.	c.p.	Volts.	Amperes.	Watts.	Watts calculated.	Diff.
1	7·43	90	·15	13·5	13·49	—
2	8·8	95	·154	14·6	14·71	+ ·7 %
3	11·26	100	·16	16	15·85	− ·9 %
4	12·5	105	·163	17·1	17·28	+ 1 %
5	15·5	110	·168	18·5	18·61	+ ·6 %
6	18·6	115	·174	20	19·97	− ·15 %
7	22	120	·179	21·5	21·38	− ·5 %

Lamp.—Wotan, 110 volts, 16 c.p.
Power characteristic.—Watts = ·01008 volt$^{1.6}$.

In all cases the calculated watts were obtained by employing the law: watts = constant × volts$^{1.6}$; and it is interesting to note that the greatest variation is only of the order of 1 per cent.

The difference between the several constants is only to be expected when dealing with several makes of lamp, and conforms with the variation in the hysteretic constants of various samples of iron.

When dealing with one particular make of lamp frequent determinations of K might form a check on the manufacture, as variations would indicate a change in the filament.

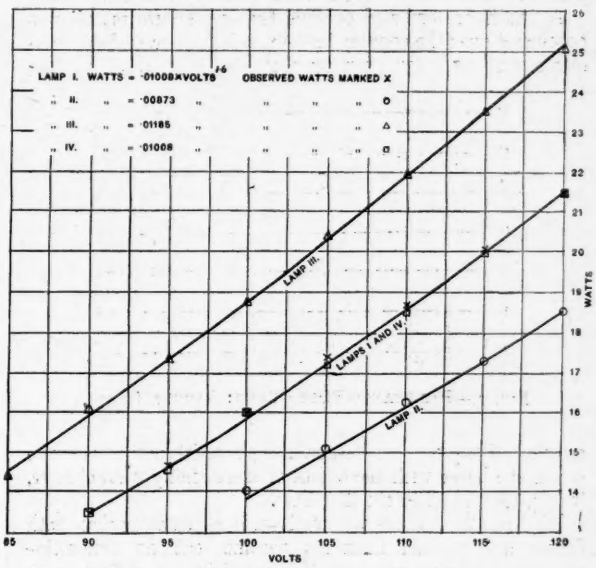

LAMP I. WATTS = ·01008 × VOLTS 1·6 OBSERVED WATTS MARKED X
" II. " = ·00873 " " " " O
" III. " = ·01185 " " " " Δ
" IV. " = ·01008 " " " " □
LAMP III.
LAMPS I AND IV.
LAMP II.
WATTS
VOLTS

Fig. 1.

The creeping-in of errors in the process may thus be readily detected.

As a result of the tests it seems clear that "the watts vary as the 1·6th power of the impressed volts" is a law for the various metal-filaments listed.

In the diagrams, fig. 1, the curves showing the relation between volts and power are plotted. The observed watts are also indicated, and all lie practically on the curves.

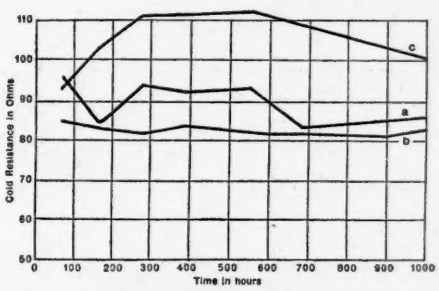


Fig. 2.—Resistance-Time Curves: Drawn-Filament Lamps.

The increasing numbers of metallic-filament lamps, coupled with the more or less extravagant claims of the rival manufacturers of drawn and pressed filament types, cannot but make the task of would-be purchasers a difficult one, and

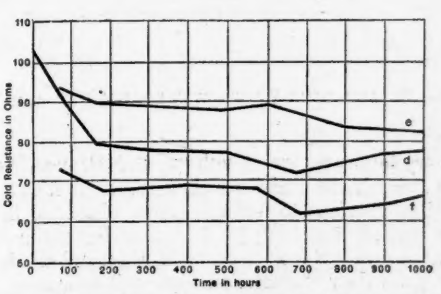


Fig. 3.—Resistance-Time Curves: Pressed-Filament Lamps.

published comparative life and efficiency tests of the several makes are rendered almost a necessity.

We are familiar with the "1-watt per candle lamp," and the fact that such-and-such a lamp saves 70 per cent. or more of energy, from the advertisements, but, as regards actual experience, are these facts? Again, the saving in energy is obviously the result of comparison with a carbon lamp, although this is generally not stated, so that the

question arises as to the saving that results due to using one metal-filament lamp in preference to another.

To obtain some such information useful from the user's point of view, the following series of tests were undertaken :—

A batch of lamps of each of the best known makes was purchased over the counter in the usual manner, and arrangements were made for running them on a constant voltage

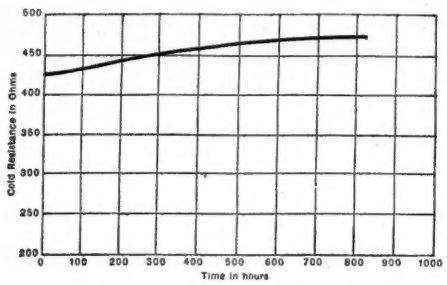


Fig. 4.—Resistance-Time Curve: Carbon Lamps.

circuit. Frequent candle-power and resistance tests were made, the latter with the object of ascertaining what change, if any, took place in the filaments.

As a result of these observations, it seems clear that both drawn and pressed filaments become entirely crystalline after use, and that when in this condition no difference in strength exists between the two. The only question is as to the period of time that elapses before the crystalline state is attained ; it appears that the drawn filaments crystallise more slowly, and, therefore, are stronger at the beginning and during the initial stage of the run.

This increased strength at the commencement will obviously assist in the manufacturing process, and render breakages in handling and transit less numerous.

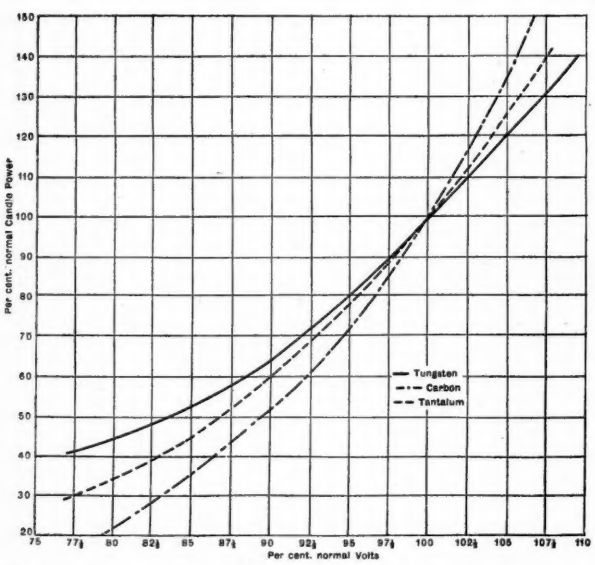


Fig. 5.—Relationship Between Candle-Power and Volts.

The crystalline nature of both types of filament is evident from a study of the resistance-time curves, figs. 2, 3 and 4, where fig. 2 refers to several drawn filaments, fig. 3 to various pressed ones, and fig. 4 to some Robertson carbons. The latter were included to serve as a general check on the results, since their characteristics are well known.

At no two periods were the resistances identical. An increase or decrease in the case of the metal lamps seems a matter of chance, and this clearly could only occur when the subject under examination was of a crystalline nature. A high resistance would indicate a bad connection between adjacent crystals, and since such occur more frequently in the drawn lamps, the presence of smaller crystals seems to be indicated.

The steady increase of the carbon filament is to be noted as a proof of its continuity ; the filament becomes thinner, the bright steely surface disappearing, and a rougher black untreated surface appearing. This new system being a better radiator than the old one, the result is a lowered temperature and decreased efficiency. The rough surface also increases the radiating area and further lowers the temperature and efficiency.

It is often stated that metallic-filament lamps are less susceptible to pressure variations than are carbon ones. In this case permanent variations only are meant, since, if the pressure is flickering or varying momentarily, the metal lamps, by reason of the low specific heat of the

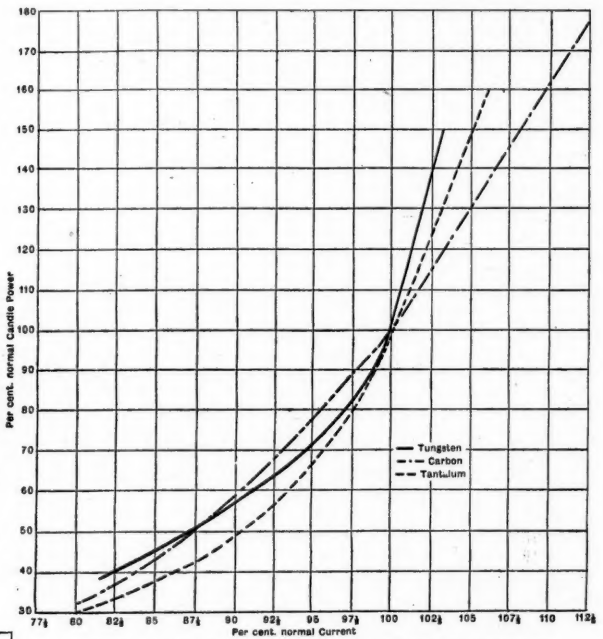


Fig. 6.—Relation of Candle-Power to Current.

filaments, will respond much more readily to the changes than will carbon ones.

As regards permanent increases, the various voltage and current indices were ascertained by the following tests :—

The lamp to be tested was arranged in series with a resistance, so that the lamp pressure was capable of considerable variation. Standard instruments were used, and the candle-power was ascertained by Lummer-Brodhun photometer and standard lamp, the latter being periodically tested against a pentane standard.

In fig. 5 is shown the relation between candle-power and terminal volts, and the voltage index obtained for the various types is given as follows :—

Lamp.		*Volts index.*
Tantalum	...	4·1—4·3
Tungsten	...	3·5—4·1
Carbon	...	6·7—7

The superiority of the metal lamp as regards a permanent change in voltage is clear. Since relatively slight reductions in pressure produce large decreases in candle-power, the importance of close regulation is apparent, while, although a correspondingly great increase in candle-power results on an increase in pressure, the rapid deterioration of the filament renders the practice a costly and unwarranted one.

The index for a particular lamp, it should be noted, is not constant for equal pressure changes, but varies slightly according to the candle-power.

In fig. 6 is shown the relationship between candle-power and current, the index obtained for each make being as under :—

Lamp.		*Current index.*
Tantalum	...	5·5—5·8
Tungsten	...	5—6·5
Carbon	...	5·2—5·4

The variation among the tungsten filaments is considerable, probably due to the different manufacturing processes.

The carbon in this respect is equal almost to the best tungsten and superior to the tantalum.

From the above, it would appear that the practice of

running lamps, when used for sub-standards in making photometric measurements, at a fixed current is the correct one. A potentiometer method is, of course, the one that ought to be adopted in maintaining a constant current.

The variation of candle-power with power supplied is interesting; in the case of the metal lamps, both tantalum and tungsten, the index is practically the same—*i.e.*, 2·4. It is not, however, constant throughout the test, but varies considerably at low candle-powers.

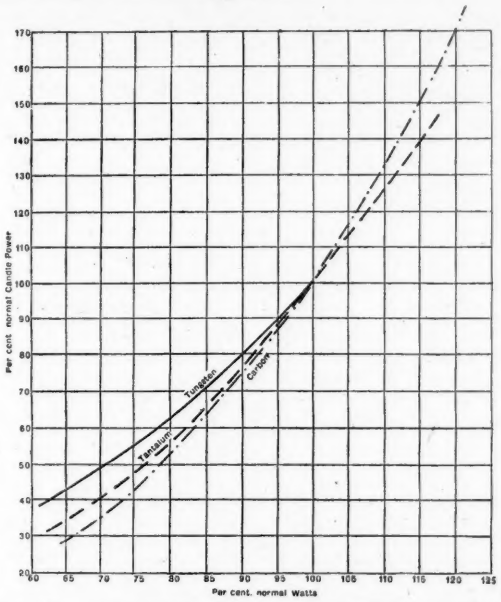


Fig. 7.—Relationship Between Candle-Power and Watts.

With regard to the carbon lamp, the index is 3, or the candle-power varies as the cube of the watts. And here, again, the index is not constant, but varies throughout the test.

In fig. 7 is shown the relationship between candle-power and power supplied, the close agreement between the tungsten and tantalum lamps being apparent.

The life tests indicate that the candle-power varies considerably during the first 50 hours or so of the run, and that this interval of time constitutes a period of instability.

For some of the lamps the period was even shorter, and when what might be called the true candle-power was attained, in most cases it remained fairly constant for several

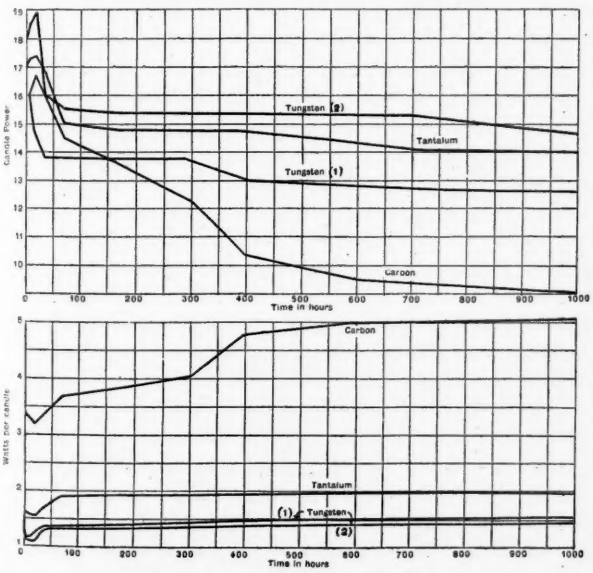


Fig. 8.—Typical Life Curves.

hundred hours. The gradual decline that is noticed in the case of all carbon lamps, and which was also a noticeable feature of the life of metal lamps (*Proceedings* I.E.E., February, 1907, paper by the author) is in many cases absent.

The smashing point in the case of metal lamps will now in general be determined by the rupture of the filament, since the usually accepted 20 per cent. drop in candle-power does not take place within its life.

In fig. 8 are shown some characteristic life and efficiency tests.

A study of these curves reveals the fact that the efficiency of the metal-filament lamps remains practically constant for the greater portion of their lives.

It seems that such lamps would serve admirably as photometric sub-standards, as the curve for the carbon lamp is varying continuously.

Two curves for tungsten lamps are shown, Nos. 1 and 2. No. 2 is seen to be much superior to No. 1 as regards candle-power and slightly as regards efficiency. No. 1 is not a chance curve, but is closely resembled by all the curves for lamps of the same batch. It seems that the tungsten lamps vary widely amongst themselves, and surely in the consumers' interest it is time that the manufacturers' names were not so religiously suppressed when publishing results of this nature.

RELIANCE ON EMPLOYER'S MEASUREMENTS.

[BY OUR LEGAL CONTRIBUTOR.]

It is safe to say that there is no more prolific source of disputes between an employer and a contractor than the practice of relying upon the measurements, &c., supplied by the employer. To rely entirely upon the figures supplied without verification is an easy, and, to all appearances, an economical way of preparing a tender; but in the long run it may turn out to be very much the reverse. Take, for instance, the erection of a large generating station. The employer, to use a term which may conveniently be applied to the company or local authority which has obtained a provisional order, has been compelled to choose a particular site. In his endeavour to secure the erection of the necessary buildings and plant, he is not likely to draw particular attention to the difficulties which must be overcome. Transport may be expensive; and foundations may be difficult to lay; but the burden of all these eventualities has to be borne by the contractor. Were he the only starter in the race for the contract, he might protect himself by adding a considerable sum to his tender in order to provide for emergencies; but the stress of competition makes it necessary to cut prices very fine.

How far, then, can the contractor legally rely upon the accuracy of the statements made in the specifications, and the figures which are given by the employer?

As a general rule, the employer's engineer tries to protect his employer as far as possible from errors in specifications. To this end he frequently inserts a stipulation that the contractor shall satisfy himself as to the dimensions, levels and nature of all existing works and other things connected with the contract; that the employer does not hold himself responsible for the accuracy of the information as to the sections or foundations of existing walls and works; and that no charges for extra work or otherwise will be allowed in consequence of incorrect information or inaccuracies in the drawings or specifications.

Again, a common form of contract (applicable more especially to the building trade) provides that the builder shall be accountable "for the full performance of this contract, and, by signing hereof, admits that the said plans, elevations, sections and specifications, descriptions and particulars before referred to, are sufficient for their intended purpose, and that without any additional or extra work, other than the works set forth thereby, or necessarily inferred to be done from the general nature and tendency of the plans and descriptions aforesaid."

Further, in order to protect himself against any error in the bills of quantities, the employer frequently insists upon the insertion of a clause to the following effect:—

"The bill of quantities upon which the tender of the contractor is based was prepared for the purpose of assisting persons tendering for the works in making their calculations, but it does not profess to give actual cube measurements or to be otherwise than approximate in the figures therein stated, and the employer will not be responsible for the accuracy of such quantities, and the builder is not to be entitled to any claim for extras based on any alleged error therein, but is responsible for the completion of the entire works, as described in the plans and specifications, at the contract price.

A notable example of the way in which a contractor may be put to loss and expense owing to implicit reliance on the measurements, &c., of the employer's engineer, is furnished by the well-known case of Thorne *v.* Lord Mayor of London (1876), L.R.I.A.C. 120. There the Corporation of London invited contractors to tender for the execution of certain works for the building of Blackfriars Bridge according to plans and specifications prepared by the engineer to the Corporation. The specification provided that the contractors were to take out their own quantities, and that the accuracy of the plans was not guaranteed by the Corporation. The contractors were warned particularly that they must satisfy themselves as to the nature of the ground through which the foundations had to be carried. Iron caissons were specified to be used in the construction of the works, but when the contractors whose tenders was accepted proceeded to use the caissons as designed, it was found that they would not resist the pressure of the water, and the plan of the work had to be altered and the use of the caissons abandoned. The contractors claimed for loss occasioned to them in attempting to use caissons according to the specification. The House of Lords held that no warranty could be implied. The following passage from the judgment of Lord Chelmsford has become historic. He said: "There can be no doubt the the plaintiff in the exercise of common prudence, before he made his tender, ought to have informed himself of all the particulars connected with the work, and especially as to the practicability of executing every part of the work contained in the specification according to the specified terms and conditions. It is said that it would be very inconvenient to require an intended contractor to make himself thoroughly acquainted with the specification, as it would be necessary upon each occasion for him to have an engineer by his side. . . . But if the contractor ought prudently and properly to have information of the nature of the work he is preparing to undertake, and the advice of a skilful person is necessary to enable him to understand the specification, is it any reason for not employing such a person that it would add to the expense of the contractor before making his tender? It is also said that it is the usage of contractors to rely upon the specification, and not to examine it particularly for themselves; if so, it is a usage of blind confidence of the most unreasonable description."

While Thorn *v.* Mayor of London may be regarded as a leading authority, the facts capable of proof in another case may not tally with it. In Pearson *v.* Dublin Corporation, 1907 A.C. 357) it was laid down that if the specifications or plans contain or involve statements of fact which are false to the knowledge of the employer, the question of fraud enters into the matter, and the contractor may be in a position to claim relief. In this connection it should be mentioned that a statement made by a person recklessly and without caring whether it be true or false, is deemed fraudulent in the eye of the law. In that case there was a contract to execute certain sewerage works. The plaintiffs covenanted to do the works described in the drawings, specifications, &c., and the defendants covenanted to pay for the works on receipt of the certificate in writing of their engineer as provided by the conditions. The specification provided, *inter alia*, that the plaintiffs must verify all representations and not rely upon their accuracy. The works in question involved the transformation of an old harbour in the Liffey into a sewerage tank. On completion the plaintiffs claimed £36,574 from the defendants on the grounds—first, that the plans showed a certain existing wall extending some 9 ft. below the ordnance datum line, which could be utilised for the purpose of the works; that this wall did not exist, and consequently the plans for the works had been altered, and the plaintiffs at the direction of the engineer, had completed the works at this extra cost; secondly, that the defendants had fraudulently misrepresented the structure and existence of this wall, and had thereby induced the plaintiffs to enter into a contract to their detriment. The defendants relied upon the absence of a certificate from their engineer, and on the conditions of the specification, and they denied the making of any representation and any fraud.

It was held that the specification only protected the defendants in respect of honest mistakes by themselves or their agents, and it was for a jury to say whether it was fraud or not. In giving judgment, the Lord Chancellor pointed out that evidence was adduced at the trial from which the jury might, if they thought right, conclude that the plaintiffs were induced to enter into the contract by statements made on behalf of the defendants. There was also evidence for the jury that those statements were made with a knowledge of their falsity, or (which was the same thing) with a reckless indifference whether they were false or true, on the part of the engineers employed by the defendants to make the plans which were submitted as the basis of the tender. Having referred to the clauses which pointed out that the plaintiffs were not to rely on the plans, he said: "Now, it seems clear that no one can escape liability for his own fraudulent statements by inserting in a contract a clause that the other party shall not rely upon them. I will not say that a man, himself innocent, may not under any circumstances, however peculiar, guard himself by apt and express clauses from liability from the fraud of his own agents. It suffices to say that, in my opinion, the clauses before us do not admit of such a construction. They contemplate honesty on both sides, and protect only against honest mistakes. The principal and the agent are one, and it does not signify which of them made the incriminated statement, or which of them possessed the guilty knowledge."

Upon this case the observation arises that if anything in the nature of legal fraud can be alleged against the employer or his engineer, he will not be allowed to take advantage of it. But he who alleges fraud must strictly prove it, and the proof of fraud is a serious and difficult matter.

Perhaps the time will some day arrive when contractors will be in a sufficiently strong position to be able to say to employers:—"We will not tender unless you will take some responsibility for unforeseen difficulties." No such position has yet been attained. Indeed, the employer—particularly when he is a local authority—appears to have it all his own way. The writer recalls a case in which a local authority were inviting tenders for the laying of a sewer. Instead of having a set of bores made on their own account, they referred the would-be tenderer to a firm of surveyors who were willing to supply certain information in their possession; but it was expressly provided that the local authority was not to be responsible in any sense for the accuracy or inaccuracy of the information so obtained. In point of fact, the information so obtained was misleading in the sense that it wholly failed to disclose the presence of a bed of wet sand which threw the contractors out in their reckoning. In the event, the contractors were practically ruined. That is a contingency—the probable ruin of the contractor—to which the employer will do well to have regard. The cost of making proper investigations may be great in the first instance; but it is nothing to the loss which may accrue if the contractor is rendered insolvent by the onerous burden of a contract.

Gas Ignition by Lamp Breakages.—The question whether fire-damp will be ignited by the fracture of an incandescent lamp bulb while the lamp is in operation is of growing importance because of the increased use of low-voltage portable electric lamps employing tungsten filaments. Technical paper No. 23 just issued by the United States Bureau of Mines gives the results of 131 tests made for the purpose of throwing some light on the problem. Mixtures containing as little as 5 per cent. of gas and others containing as high as 12·4 per cent. of gas were ignited by 1½ c.p., 3½-volt, 3—10 ampere miniature lamps, which were smashed while operating at rated voltage. Out of the total of 131 tests, 78 caused ignition.—*Electrical World.*

TRADE STATISTICS OF ROUMANIA.

THE following statement, showing the imports of electrical and similar goods into Roumania in 1910, is taken from the official trade statistics which have recently been issued; the figures for 1909 are added for purposes of comparison, and notes of any increases or decreases are given:—

	1909. Kilogs.	1910. Kilogs.	Increase or decrease. Kilogs.
Electric insulators of faience and porcelain even combined with other materials.—			
From Austria	32,000	63,000	+ 31,000
„ Germany	37,000	79,000	+ 42,000
„ Italy	—	1,000	+ 1,000
„ Other countries ...	1,000	3,000	+ 2,000
Total ...	70,000	146,000	+ 76,000
Boilers.—			
From Great Britain ...	2,000	26,000	+ 24,000
„ Austria	92,000	86,000	— 6,000
„ France	30,000	7,000	— 23,000
„ Germany	179,000	421,000	+ 242,000
„ Other countries ...	20,000	1,000	— 19,000
Total ...	323,000	541,000	+ 218,000
Iron wire, galvanised, &c.—			
From Great Britain ...	62,000	48,000	— 14,000
„ Austria	51,000	103,000	+ 52,000
„ Belgium	15,000	9,000	— 6,000
„ France	2,000	—	— 2,000
„ Germany	261,000	330,000	+ 69,000
„ Holland	86,000	2,000	— 84,000
„ Other countries ...	1,000	1,000	—
Total ...	478,000	493,000	+ 15,000
Electric incandescent lamps.—			
From Austria	5,000	6,000	+ 1,000
„ Germany	13,000	16,000	+ 3,000
„ Other countries ...	—	1,000	+ 1,000
Total ...	18,000	23,000	+ 5,000
Copper wire.—			
From Great Britain ...	—	66,000	+ 66,000
„ Austria	20,000	22,000	+ 2,000
„ Germany	104,000	83,000	— 21,000
„ Other countries ...	3,000	3,000	—
Total ...	127,000	174,000	+ 47,000
Steam engines.—			
From Great Britain ...	30,000	7,000	— 23,000
„ Austria	129,000	69,000	— 60,000
„ Germany	1,415,000	2,398,000	+ 983,000
„ Other countries ...	64,000	50,000	— 14,000
Total ...	1,638,000	2,524,000	+ 886,000
Petroleum engines.—			
From Great Britain ...	932,000	817,000	— 115,000
„ Austria	475,000	600,000	+ 125,000
„ Belgium	93,000	163,000	+ 70,000
„ Germany	1,462,000	1,159,000	— 303,000
„ Switzerland ...	237,000	257,000	+ 20,000
„ Other countries ...	42,000	87,000	+ 45,000
Total ...	3,241,000	3,083,000	— 158,000
Gas, compressed air, &c., engines.—			
From Great Britain ...	45,000	62,000	+ 17,000
„ Austria	85,000	27,000	— 58,000
„ Germany	343,000	165,000	— 178,000
„ Switzerland ...	58,000	7,000	— 51,000
Total ...	531,000	261,000	— 270,000
Dynamo-electric machines, electric motors, converters, transformers, &c.—			
From Great Britain	2,000	1,000	— 1,000
„ Austria	22,000	20,000	— 2,000
„ Belgium	15,000	9,000	— 6,000
„ France	1,000	5,000	+ 4,000
„ Germany	557,000	711,000	+ 154,000
„ Other countries ...	16,000	3,000	— 13,000
Total ...	613,000	749,000	+ 136,000
Accumulators and spare plates.—			
From Austria	133,000	226,000	+ 93,000
„ France	1,000	1,000	—
„ Germany	34,000	22,000	— 12,000
„ Other countries ...	—	2,000	+ 2,000
Total ...	168,000	251,000	+ 83,000
Arc lamps.—			
From Austria	1,000	1,000	—
„ Germany	13,000	8,000	— 5,000
„ Other countries ...	1,000	—	— 1,000
Total ...	15,000	9,000	— 6,000
Electric apparatus for telegraphs and telephones.—			
From Austria	1,000	2,000	+ 1,000
„ Germany	15,000	8,000	— 7,000
„ Other countries ...	7,000	2,000	— 5,000
Total ...	23,000	12,000	— 11,000
Ditto for transmission of power and light.—			
From Austria	1,000	2,000	+ 1,000
„ Germany	12,000	18,000	+ 6,000
„ Other countries ...	2,000	—	— 2,000
Total ...	15,000	20,000	+ 5,000
Interrupters, &c.—			
From Austria	7,000	7,000	—
„ Germany	63,000	72,000	+ 9,000
„ Other countries ...	1,000	3,000	+ 2,000
Total ...	71,000	82,000	+ 11,000
Cables for transmission of electricity and insulated wire.—			
From Great Britain ...	27,000	1,000	— 26,000
„ Austria	18,000	51,000	+ 33,000
„ Germany	342,000	692,000	+ 350,000
„ Belgium	3,000	18,000	+ 15,000
„ Other countries ...	—	4,000	+ 4,000
Total ...	390,000	766,000	+ 376,000
Rails for tramways and railways.—			
From Austria	356,000	1,373,000	+ 1,019,000
„ Belgium	2,193,000	1,031,000	— 1,162,000
„ Germany	2,162,000	4,442,000	+ 2,280,000
„ Holland	1,747,000	1,258,000	— 489,000
„ Russia	5,635,000	6,216,000	+ 581,000
„ Other countries ...	125,000	87,000	— 38,000
Total ...	12,218,000	14,407,000	+ 2,189,000
Locomobiles.—			
From Great Britain ...	409,000	1,010,000	+ 601,000
„ Austria	457,000	1,143,000	+ 686,000
„ Germany	824,000	1,096,000	+ 272,000
„ Other countries ...	16,000	19,000	+ 3,000
Total ...	1,706,000	3,268,000	+ 1,562,000
Electric apparatus for bells.—			
From Austria	2,000	2,000	—
„ Germany	3,000	3,000	—
Total ...	5,000	5,000	—
Electric batteries for medicine and chemistry.—			
From Austria	1,000	1,000	—
„ Germany	3,000	2,000	— 1,000
Total ...	4,000	3,000	— 1,000

The Electric Smelting of Iron Ore in Norway.—

H.M. Consul at Christiania (Mr. E. F. Gray) reports that the Hardanger Electric Ironworks were started in November, 1911, and during a short spell of activity they produced rather over 300 tons of raw iron, which were exported. The ore smelted came from the Klodeberg Mine, near Arendal, containing 40 to 45 per cent. of iron. The ore furnace is calculated for a maximum of 3,500 H.P. Further experiments were to be made with ore from Rödsand. A new electric mass furnace is being made, to act at first as a reserve furnace, and an electric steel furnace will probably be constructed during 1912.

The Arendal Fossekompagni has projected iron smelting works near Arendal, and is to employ 8,000 H.P. It is hoped to begin working on ore from the fields near Arendal and Lyngör in the spring of 1913. The Tinfos Ironworks for electric smelting will soon begin producing, but have been delayed by a lock-out and other causes. The Stavanger Electric Steel Works for the manufacture of steel from old battleships, &c., will probably not start working before the latter half of 1912; they will employ some 1,000 to 1,500 H.P. Hammering works are under construction.

Several new works of the kind are already under consideration.—*Board of Trade Journal.*

GERMAN TRANSFORMER WAGONS.

The installation of rural power transmission plants has placed electric current at the disposal of farmers for the operation of all kinds of agricultural machinery even in fields situated at a considerable distance from the farm. The high-pressure distributors are generally provided with connections for this purpose, which allow a transformer to be connected up to them. Since this transformer is employed at a number of different points, it is mounted

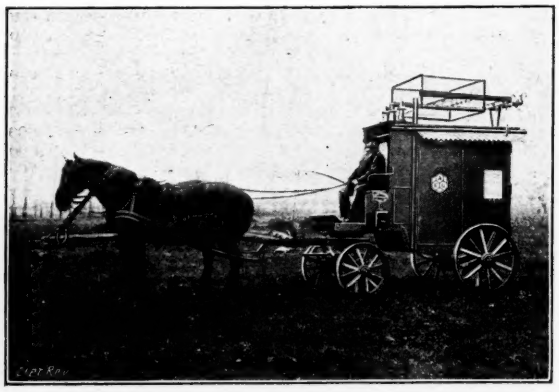


Fig. 1.—Transformer Wagon for Farm Use.

on a wagon and can be transported from place to place. As a substitute for the primitive arrangements hitherto in use, the A.E.G. has designed a special outfit which complies with the most exacting requirements with regard to safety.

In view of the apparatus it contains, the A.E.G. transformer wagon is mounted on good springs, and in order to ensure satisfactory earthing of all parts it is constructed of iron. The apparatus contained in the interior is conveniently accessible at all times through suitably arranged doors. The current is led to the

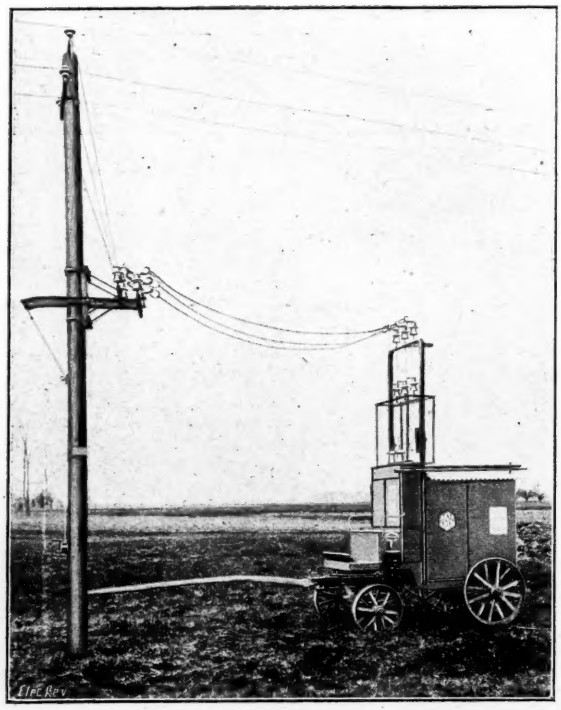


Fig. 2.—Transformer Wagon Coupled to Transmission Line.

wagon through a bow collector which can be lowered during transport. A protective lattice which surrounds the current collector serves as a support for the latter in the lowered position and keeps it steady when in the raised position.

In this position the connection with the high-pressure distributor is carried out by means of the field connection (fig. 2). This is specially designed for its purpose and consists of three fixed insulators and three insulators which can be hinged down some distance. The latter carry the hooks for the connection of the portable conductor, which can only be hung in position when the current is switched off. Inside the protective cover the high-pressure leads conduct the current by means of leading-in tubes to the fuses, choking coils, oil switches, &c., and thence in a very simple manner to the transformer.

The high-pressure equipment can be chosen according to requirements. The low-pressure equipment consists of the meter, the fuses, the excess-voltage fuses, and the terminal box. A portable cable leads to the current-consuming apparatus, and may be several hundred metres in length. For example, in the case of ploughs, it may be as long as 1,000 m. For this reason, the portable transformers are designed on the low-pressure side for pressures ranging between 220 and 380 volts in the case of short distances, and from 500 to 1,000 volts for long lengths of cable.

These transformer wagons, which are built for 40 or 80 K.V.A., in spite of the high pressures adopted, ensure the greatest reliability in operation and afford adequate protection for persons employed directly or indirectly in their neighbourhood. The portable transformers are used for the operation of ploughs, threshing machines, drainage and irrigation pumps, &c. The use of a portable transformer in connection with rural power transmission plants enables a considerable reduction in the no-load losses and the production costs to be effected.

THE RECENT WORK OF MR. CARL HERING.

An advantage always accrues to a community when one of its number devotes himself specifically to one particular object. For this reason, it is of interest, in view of the rapid advances which are now being made in the design and operation of electric furnaces for the production and refining of steel and other metals, to refer to the researches of Mr. Carl Hering, in order to gain some clear appreciation of the bearing which the work of this well-known American pioneer in electrometallurgy, has upon the general problem of the application of electricity to the working of metals.

Two features in electric furnace work need to be kept in mind in order to see the position. The first is, that modern furnaces are now being made of increasingly large capacity as the electrical process is emerging from the experimental to the practical stage, and therefore the currents dealt with are increasingly powerful. The

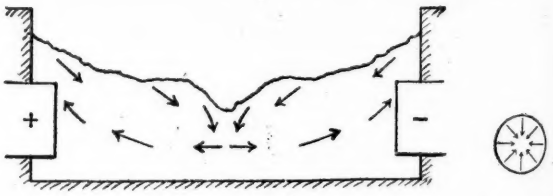


Fig. 1. Fig. 2.

second point is, that the molten masses in the electric furnaces present themselves as conductors of electricity which are in a fluid condition, and, therefore, their power of mechanical cohesion is small. The result is that the presence of unsuspected internal forces in a conductor due to the current carried by it has been found, and the value of Mr. Hering's former work was in demonstrating this presence. The "pinch phenomenon," which term describes the tendency of a current to contract the cross-section of the conductor, and even to produce rupture of the circuit, which becomes evident when the conductor is liquid, was discussed in 1907 before the American Electrochemical Society, and in 1909 the practical bearing of this phenomenon upon the design of electric furnaces was shown before the same society in a paper on "The Working Limit in Electric Furnaces due to the Pinch Phenomenon."

It seems, however, a perfectly natural supposition that if a conductor contracts in cross-section under the influence of the pinch effect, the material so displaced must move somewhere else, and, as a matter of fact, as indicated in fig. 1, taken from a publication by Mr. Hering in the *Journal* of the Franklin Institute, the material moves lengthwise to the conductor near the central axis with considerable force. Mr. Hering argues in this article on "The Stretching of a Conductor by its Current," that the current is subjected to a longitudinal stretching force in addition to a transverse compressive one. He supports this view by several observations. One of these is the action of an arc, which is a perfectly flexible conductor, in wandering about when between vertical electrodes, and even crawling up the side of the electrode, as if it were trying to lengthen itself. He also cites the case of a flexible bent conductor trying to straighten itself, and argues that the forces exerting the straightening action still exist when the conductor is straight, and hence tend to lengthen the conductor. The well-known trough experiment of Ampere and the action of the current passing through a "U"-shaped copper bar in two mercury cup terminals in forcing the bar out of the cups when the current is strong enough, point the same way. As like magnetic lines of force repel one another, and as every current-carrying conductor is encircled by like circular lines of force, these lines must repel each other in the direction of the axis of the conductor, and therefore produce a stretching force. Other experiments are also cited in this paper tending in the same direction.

Mr. Hering likens the conductor carrying a current to a wire surrounded by stretched rubber bands like umbrella rings which are also crowded together laterally. Their contraction produces an analogue of the "pinch" effect, while their lateral expansion represents the lengthening effect on the conductor. He suggests that the stretch of the conductor carrying a current follows as a consequence, if it is true that a line of force is rigid with the material of the conductor carrying the current which produces it. He calls attention to three imperfections in the usual text-book statements, arguing firstly, that it is not *currents* that attract and repel one another, but the *material of the conductor* which is attracted or repelled: secondly, that the material in and about which large lines of force are generated is moved, or affected, by these forces, this statement being preferable to the usual one that like *forces* repel, and unlike, attract; and, thirdly, that the generation of electromotive force is not produced by cutting the *circuit* by lines of force, but the *material* of that circuit which is cut. If a circuit, but not the material, is cut, there will be no induction. He, therefore, deduces the following conclusions which may be taken verbatim from the paper referred to:—

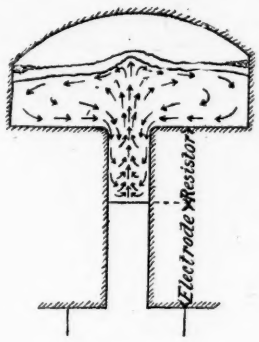


Fig. 3.

"In a conductor free from all external influences a current exerts a stretching force, due to its magnetic effect, which is independent of the direction of the current or of the length of the conductor, and is presumably proportional to the square of the current, and inversely proportional to the cross-section; it continues to act no matter what length the conductor has been stretched by it, and is, therefore, not of the nature of a strain; it is affected by neighbouring currents, and becomes less as these neighbouring currents neutralise the magnetic effect of the current, being zero in a perfectly non-inductive circuit; when it produces motion a counter electromotive force is produced; when such motion is reversed by a stronger opposing mechanical force, a direct electromotive force is produced."

It has been necessary to discuss at such length the author's more or less theoretical investigations in order to appreciate the work which underlies the design of a new type of electric furnace, which was described in a paper by Mr. Hering before the American Electrochemical Society in New York. In referring to the "pinch" effect, Mr. Hering illustrates a method whereby this effect is put to good use. In fig. 2 the circle represents the cross-section of a cylindrical conductor, the forces of the "pinch" effect tending to act radially as shown by arrows. If the conductor were made to be the electrical column of liquid, as, for example, the portion marked "resistor" in fig. 3, consisting of a hole in a non-conducting material closed at the bottom by an electrode, and filled with liquid, then these forces act horizontally

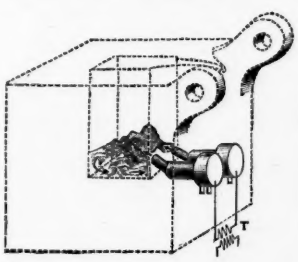


Fig. 4.

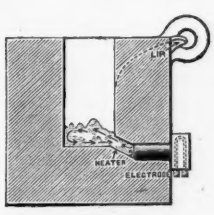


Fig. 5.

and perpendicularly to the axis along the whole length. The mutual attraction of the parallel electric currents in such a conductor, act on the material constituting the conductor, and the liquid particles are moved bodily from the circumference to the central axis, and therefore a suction is created at the periphery and a pressure at the centre. By hydraulic action the radial forces in turn produce corresponding longitudinal forces at the centre and at the periphery, and the action is shown by arrows, a species of fountain being formed. The direction of this hydraulic flow is the same for direct or alternating current, and hence a valveless electromagnetic pump is formed. This phenomenon, known as the "squirt" phenomenon, has been adapted as a basis for the liquid resistor furnace.

In the *Journal* of the Franklin Institution, Mr. Hering describes this furnace in more detail. The liquid columns or resistors, of which there are two (one for each electrode), are so proportioned that the whole heat for the furnace is generated in them, and the diameter and current are so proportioned that the "pinching" force is sufficient to produce the desired circulation. In turn each particle of the liquid enters the resistor, and it is here immediately highly heated and ejected, being in the resistor only about one second. There the heated metal is forced to the top where, in the case of steel refining, it comes into intimate contact with a blanket of slag, the chemical action taking place there. The cooler material on the bottom flows in the resistor, and is in turn heated and ejected. Where three-phase current is used there are three similar resistors and electrodes. In order to show how this principle may be applied, figs. 4 and 5 show a small type of crucible tilting furnace, which tilts round the lip, so as to pour directly into the moulds. Various ways of starting it may be adopted. A small liquid charge may be put into it, just enough to connect the ends of the electrodes when the crucible is tilted; a small charge may be melted in the crucible by means of an oil flame, or a casting

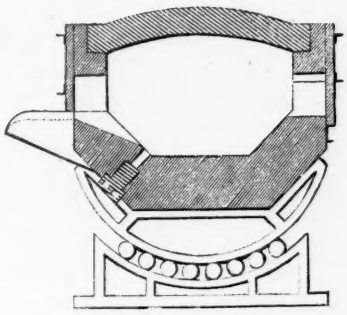


Fig. 6.

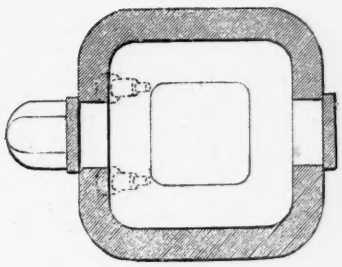


Fig. 7.

may be made to fit the bottom, and this casting may be subsequently melted electrically, or a small charge may be always left in the crucible, and in this case the charge can be readily melted with the current when it has become frozen. In order to show how these resistors or squirting tubes and their electrodes may be applied to the usual form of tilting furnaces, figs. 6 and 7 may be studied. The former is a vertical section through one of the two electrodes and tubes, while the latter shows a top view of a horizontal section at about a level with the doors. It is claimed that, with this type of furnace, there is a very quick action, which results in a large output per day and less stand-by losses per ton, also a rapid refining action, owing to the continual renewal of the surface in contact with the slag. There is rapid purification of the suspended matter, such as slag, oxides, gases, &c., as these are freed as the liquid reaches the top and deposits such matter in the slag. The rapid and systematic circulation produces practically perfect homogeneity, while the temperature is reduced to the lowest possible value necessary for the chemical reaction, thus diminishing loss due to excess of temperature. The method also tends to certain improvements in design, such as heating from the bottom, which is a rational method; the possibility of making the hearth deep and narrow instead of shallow and broad, this reducing loss of heat from the walls; the use of metal electrodes, which lose less power than those of carbon or graphite; no consumption of the electrodes, thus eliminating an important item of cost in arc furnaces, and also the necessity for continual adjustment of the electrode and contamination of the material with that of the electrode. Looked at from the electrometallurgical point of view, the furnace can be easily and accurately regulated by varying the voltage of the transformer. Heat can be added at the top in the form of gases for preheating the cold material and producing low temperature heat, so obtaining increased economy; and there is no reduction in the power factor, as the current is generated in a separate transformer. From the maintenance point of view, the simplicity and compactness of the construction itself, ease of operation and the facility with which repairs of the tubes can be made, makes the operating cost very low, and it may be stated that the larger the furnace, the better does the principle apply, while it is capable of application to existing open-hearth furnaces.

The furnace described was, some time ago, run daily in order to carry out certain experiments and to determine some interesting constants, and these experiments were all very satisfactory. Another furnace is now being built, and it is expected that, when particulars of this type are made public, some very interesting developments will be shown relating to yet another physical phenomenon, which reveals itself and becomes powerful under conditions of high current densities.

Manchester Electro-Harmonic Society.—The season 1912-13 will be opened by a smoking concert next month. The secretary (Mr. I. Hill, 24, Brazennose Street, Manchester) will be very pleased to forward application forms for membership to any gentlemen who are desirous of becoming members. There are at present about 100 members, and the committee is anxious to receive as many applications as possible before the opening concert.

ELECTROLYTIC CONDENSERS FOR THE PREVENTION OF SPARKING AT CONTACTS.

It has long been known that sparking at contacts can be prevented by the use of condensers, but the expense of the large capacities involved even for circuits of quite small power when the voltages are low, has proved a bar to their widespread use hitherto.

In an article in the *E.T.Z.* for August 29th, Dr. Karl Siegl describes the successful use of a cheap form of iron-alkali electrolytic condenser in connection with electric clock contacts. He prefers to introduce the condenser in series with the contact and the supply battery, rather than as a shunt to the contact, as the former arrangement greatly simplifies the construction.

After a great deal of experimenting, Dr. Siegl found that only electrodes of mercury or of iron were suitable for the purpose, and these gave the best results in a concentrated solution of caustic potash or caustic soda. Since solid iron electrodes are more easily dealt with than liquid mercury ones, iron has generally been adopted. Provided the current density is kept moderate, no chemical action whatever takes place, and no gas is given off, so that the whole can be hermetically sealed and requires no attention.

When such a cell is subjected to a voltage of from ½ to 1 volt, a momentary current flows (lasting from a few hundredths of a second to many seconds, according to the size of the plates), and is then absolutely cut off automatically by the rapid formation of an oxide coating on the anode. On reversing the voltage a similar momentary current flows in the opposite direction, and so on at every swing of the clock pendulum carrying the contacts.

The arrangement usually adopted is indicated in fig. 1 : *p* is the seconds pendulum of any standard clock. The pendulum spring P F is fixed at its ordinary supporting point into a piece of metal M, about 5 cm. long. This piece is itself supported from a very short

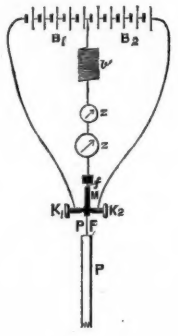


Fig. 1.

spring *f*; M carries two contacts, only just free to move between the two contact screws K_1 and K_2, so that on breaking with one screw it makes contact with the other.

The ends of the battery B_1 B_2 are connected to the two contact screws, whilst the middle point of the battery leads to the condenser or valve cells *v*, and thence through the clock electromagnetic mechanism *z z*. By choosing the area of plate in the valve cells correctly the current impulses can be made of sufficiently short duration to enable the contact to be broken every time at zero current, and, therefore, without any sign of sparking.

Thus, if the area of plate is very small (small iron wires), the current rush is over in a few hundredths of a second; but, at the same time, the initial resistance is too great to allow enough current for operating the clock mechanism to pass. Also the high current density causes gas evolution and possible destruction of the oxide coating, accompanied by a needle-like black deposit. If the area of plate is increased to 1 or 2 sq. cm. gas is no longer given off, but the resistance is still too high.

At the other extreme, with plate areas of 50 sq. cm. or more, the resistance of the cell becomes so low that a quite small battery passes sufficient current, but, owing to the large capacity, this current continues for too long a period. Experience showed that, for second clocks with a circuit resistance of under 100 ohms, plate areas of from 20 to 40 sq. cm. were suitable, and enough current could be got through these with 4 or 5 volts. As a rule, the ratio of number of valve cells to number of battery cells connected across them is made two, but for specially perfect protection of the contacts it may be made three or more. The valve plates are sometimes made up in the form of concentric sheet iron tubes; more often the plates form the sides of narrow troughs, both sides of the plate being thus available and giving the whole arrangement a very compact form.

The valves gradually increase in resistance for the first 10 or 20 hours of working, so that the best number of cells should not be finally determined until after this time has elapsed.

The length of time for which the current impulse lasts depends, in the first place, on the relation of the capacity of the cell to the initial resistance of the cell and the resistance of the outside circuit, and, in the second place, on the relation of the number of cells to the voltage applied. By suitably changing these various factors either minute or second impulses can be equally readily obtained.

THE FAILURE OF A TRAMWAY UNDERTAKING.

[FROM A LEGAL CONTRIBUTOR.]

Signs are not wanting that those sections of the Tramways Act, 1870, which relate to tramways which it is found impossible to run at a profit, may soon have to be called into operation in certain parts of the country. In the department of electric traction as in other departments which are of interest to the electrical world, there is sometimes over-production. In a burst of enthusiasm, enterprising persons may have found the money for laying tramways in a district which, contrary to expectation, never develops even under the stimulus of electric traction. Receipts fall off, the cost of repairs and renewals has to be met, and the heavy burden of maintaining the track has to be borne as a first charge upon the undertaking. In the result, the tramway company may be forced to face the music of liquidation. Failures of this kind only become publicly known where the undertaking is in the hands of a private company. If a local authority owns the trams, the loss, if any, is borne by the ratepayers. Nor is there much outcry raised about the failure of the undertaking in such circumstances, because it can always be argued that, although there is a loss, the undertaking is conferring benefits upon the poorest of the poor.

An interesting and instructive example of the entirely blameless failure of a private company is afforded by the case of the Scarborough trams. The following epitome of facts is derived from a report of a case which was heard at the Scarborough Petty Sessions in January (see Electrical Review, January 20th, 1911, page 90): The Scarborough Tramway Co. were summoned at the instance of the Corporation for failing to provide a reasonable service of trams, as provided by Sec. 92 of the Scarborough Tramways Act, 1902. It appeared that the trams started running in October, 1904, and continued to run until October, 1910, when the directors of the company, finding that the undertaking was being carried on at a loss of £2,000 a year, decided to suspend operations. An application which they made to the Board of Trade, to be allowed to suspend traffic during the winter, was refused. The solicitor who appeared for the company urged that the proper remedy of the Corporation was to take advantage of Sec. 42 of the Tramways Act, 1870, which provides that if after inquiry by the Board of Trade, the promoters were found insolvent, their powers should be at an end at the expiration of six months, unless the concern was taken over by the local authority. Eventually the magistrates made an order imposing a penalty of 10s. a day upon the company for 28 days, although it was pointed out that there was nothing upon which the penalties could be levied, inasmuch as a Receiver had already been appointed to receive the tolls on behalf of the debenture-holders.

The ultimate fate of this unfortunate undertaking cannot be predicted with any certainty; but it serves to draw attention to those sections of the Tramways Act, 1870, which make provision for the case of an insolvent tramway company, to which, for the benefit of companies who may find themselves in the like parlous condition, we now propose to draw attention.

Sec. 41 of the Act provides that if at any time the promoters discontinue the working of a tramway or any part thereof for three calendar months (such discontinuance not being occasioned by circumstances beyond the control of such promoters, for which purpose the want of sufficient funds will not be considered a circumstance beyond their control), the Board of Trade may declare that the powers of the promoters in respect of the tramway shall be at an end. Thereupon the powers of the promoters are to cease and determine, unless they are purchased by the local authority in accordance with the compulsory purchase clause of the Tramways Act. If such an order is made, the road authority of the district may, within two months, remove the discontinued tramway at the cost of the promoters, and if the promoters fail to pay the cost, the road authority may sell the materials of the tramway either by public auction or private sale, and reimburse themselves out of the proceeds of such sale. The balance remaining over is paid to the promoters.

Upon this section the question arises, what are "circumstances beyond the control of the promoters?" It is conceived that a failure by lessees of the undertaking would not be a failure on the part of the promoters, and could not have made the subject of an order. The road authority are not obliged to remove the tramway, but no one but the promoters would have power to work it.

Sec. 42 of the same Act specifies the remedy for the insolvency of the promoters. It provides that if after the opening of a tramway it appears to the local authority that the promoters are insolvent, so that they are unable to maintain the tramway or work the same with advantage to the public, and a representation to that effect is made to the Board of Trade, the Board may direct an inquiry by a referee into the truth of the representation. If the referee finds the promoters to be insolvent, the Board may declare that their powers shall come to an end within six months unless they are purchased by the local authority. Thereupon the road authority may remove the tramway upon terms similar to those specified in the preceding section:—

It was held in one case (Pontypridd and Rhondda Valleys Tramways Co., Ltd. (1889) 58 L. J. Ch. 536), that an inquiry of this kind may be set on foot, even after a company has gone into liquidation.

It remains to consider the conditions in which a tramway company may be wound up. A tramway company may be wound up in the ordinary way if registered under the Companies' Acts, or it may be wound up as an unregistered company if it consists of

more than seven members, and is not registered under the Companies' Act, inasmuch as it is not a railway company within the exception contained in Sec. 268 of the Companies' Act, 1908. The fact that the preamble of the Tram Company's Act states that the construction of the tramway would be to the public advantage does not preclude a winding-up order, although this will make the Court more careful not to make the order until it is assured that such order is the best or only way out of its difficulties. Nor will an order be refused because the undertaking could not be sold without an application to Parliament, as such an application may be sanctioned by the Court.

The application for the order may be made by the company itself; by other persons entitled in the ordinary way to ask for such order, and by the debenture-holders in virtue of their rights as ordinary creditors, in spite of their previous exercise of their remedies as debenture-holders.

Debenture-holders, however, are in the event of default by the company entitled only to the appointment of a receiver of the undertaking of the company, and the net earnings thereof, and not to an order for the sale to the undertaking or to the appointment of a manager. The Court fully recognises the jurisdiction to wind up tramway companies, even on the application of debenture-holders, but debenture-holders are not promoters and have no right to exercise the statutory powers of promoters.

ELECTRIC IRON SMELTING.

In our issue of July 12th we published a summary of the results obtained during the first six months' work with the electric iron smelting furnace at Trollhättan, Sweden. The experience gained during that time naturally led to various improvements, and the furnace was, therefore, shut down to effect the necessary alterations. It was again started in September, 1911, since which time it has been in continuous operation.

The alterations related mainly to improved means for cleaning and circulating the furnace gas. Round electrodes were also introduced, in order to permit of their being joined end to end. Through this arrangement the waste of electrodes has been reduced to practically nil.

The results have shown a marked improvement through reduced current consumption and reduction of the quantities of charcoal and electrodes. Different kinds of ore have been tried, and long series of tests made with varying proportions of lump ore and concentrates. These show that any larger proportion than 30 per cent. of concentrates interferes with the smooth running of the furnace owing to the compactness of the charge, which prevents the passage of the gas.

On account of the varying and, for long periods, unfavourable conditions under which the furnace has worked, the average results during the entire period of working do not represent the actual efficiency of the furnace. We, therefore, select as typical the results of one month's working, when the conditions may be regarded as having been normal. These results are as follows:—

	1911.
Pig-iron produced, tons	537·9
Quantity of slag, tons	88·9
Iron in the ore, per cent.	67·65
Iron in the ore and lime, per cent.	65·02
Quantity of slag per ton of iron, kg.	165
Charcoal used per ton of iron, kg.	339·9
Average load, KW.	1,407
Average power, H.P.	1,913·5
*Current used per ton of iron, KW.-hours ...	1,749
†Iron produced per KW.-year, tons	5·01
Iron produced per H.P.-year, tons	3·68
Average CO_2 contents in gas, per cent.... ...	29·27
C per cent.	3·64
Si " "	0·36
Mn " "	0·40
S " "	0·009
P " "	0·018

* According to instruments at the furnace.
† Estimated on the basis of 8,760 KW.-hours per KW.-year.

The practical success of the process is shown by the number of plants built or planned. These are:—

Completed—		
Trollhättan, Sweden,	1 furnace	2,500 H.P.
Domnarfvet, "	1 "	3,500 "
Hagfors, "	2 furnaces, at 3,000 H.P.	6,000 "
Hardanger, Norway	1 furnace	3,500 "
Under Construction or Planned—		
Hagfors, Sweden,	1 furnace	3,000 H.P.
Nykroppa, "	3 furnaces, at 3,000 H.P.	9,000 "
Hardanger, Norway	1 furnace	3,000 "
Arendal, "	3 furnaces at 3,000 H.P.	9,000 "
Switzerland	1 furnace	2,500 "
Total, furnaces for	... ...	42,000 H.P.

The Hagfors and Nykroppa Works, Sweden, both belong to the Uddeholm Co. The working of the first furnaces at Hagfors proved so satisfactory that the company have decided to substitute electric smelting for their present blast furnaces at both works. They are expending about £330,000 for the new plant and for harnessing sufficient water-power. The report of the directors states that the electric smelting has been found more economical and gives a better product. Besides this, two-thirds of the present consumption of charcoal will be saved, and consequently a large quantity of wood will become available for the company's sulphite pulp works and other purposes.

We are indebted for the above information to Electro-Metals, Ltd., 9½, Union Court, Old Broad Street, London, E.C., who have acquired the rights to this process for the British Empire, the United States and Mexico.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to this column should be written on one side of the paper only.*]

"Volt" writes:—"The tenants of a private estate require a supply of electricity from an electrical company working under Parliamentary powers—the estate being within the area of supply.

"Before erecting poles for the purpose of supplying such consumers, is it not necessary for the company to first obtain the consent of the owner of the estate, or, failing that, to apply to the Board of Trade for compulsory way-leaves?"

*** It is clear that poles cannot be erected on, nor can wires be suspended over, the land of any person without his consent; nor has the Board of Trade any power to grant compulsory way-leaves. Sec. 10 of the Electric Lighting Clauses Act, 1899, provides that undertakers shall not, without the express consent of the Board of Trade, and where the local authority are not themselves the undertakers, of the local authority also, place any electric line above ground, except within premises in the sole occupation or control of the undertakers, and except so much of any service line as is necessarily so placed for the purpose of supply. It would seem as if "Volt" can only proceed to obtain his way-leaves by agreement with the land-owner concerned.

"Lex" writes:—"I should be much obliged if you would inform me whether it is a fact that municipal authorities are compelled by law to advertise for tenders for work involving the outlay of £100 or more; also whether they are obliged to publish the amounts of such tenders, or at least to disclose them to any ratepayer who may apply for the information. It seems to me that in the absence of such compulsory publication, there is no check on improper transactions, which would be detrimental both to the public welfare and to that of the honest tenderer."

*** Except in the case of an urban authority there does not appear to be any necessity for a local authority to advertise for tenders, although the practice is generally adopted.

Urban authorities are compelled by law to offer certain contracts for public tender. Thus it is provided by Sec. 174 (4) of the Public Health Act, 1875, that before any contract of the value or amount of £100 or upwards is entered into by an urban authority, ten days' public notice at least shall be given, expressing the nature and purpose thereof, and inviting tenders for the execution of the same, and such authority shall require and take sufficient security for the due performance of the same. Interesting questions have arisen in practice as to the legal effect of this provision. Thus in one instance (see the Electrical Review, March 2nd, 1906), a certain municipal council, having resolved to extend its electrical plant, sent out to a number of electrical manufacturers a specification in which a special type of engine (one firm's exclusive speciality) was asked for, the type of the generator being left open. The matter was not advertised. A firm of engine builders not making the type specified by the engineer obtained permission to tender, but, contrary to the specification, they quoted for their own type of engine. Their price was lowest, but they were ruled out as having failed to comply with specification.

The following points arise: (1) Should the matter have been settled with the contract being publicly advertised? (2) Was the engineer acting within his rights in specifying a particular type of engine—a fact which conceivably might allow the price being increased, because of a "monopoly" given to that favoured type? It is a frequent practice for dynamo builders to submit alternative tenders for their machines driven by different types of engines. In this way the engineer can obtain his end without leaving an opening for unfair competition. Bearing in mind that the local authority in question was a municipal body, the legality of this particular method of obtaining tenders would seem to be open to question. The object of the legislation is manifestly clear; it is to give the public an assurance that there shall be no favouritism, and that the ratepayers' money shall be expended as economically as possible. A further question has also arisen. Is a municipal body at liberty to state that no tender will be considered unless it include a particular type of engine? Although there does not appear to be any direct authority on the point, it constitutes, in the writer's view, an abuse of the powers which are conferred upon local bodies by Parliament, and opens the door to unfair dealing.

It is a common practice for local authorities and other bodies inviting tenders to draw special attention to the fact that the lowest tender will not necessarily be accepted. The knowledge that the job will not as a matter of course be handed over to the lowest bidder tends to encourage offers from firms of repute, who

need not fear that mere stiffness of price spells instant rejection. Where, however, the party inviting tenders is a local authority, it seems that there may be a *vis a tergo*, in the shape of a Government office, to be reckoned with. Thus, when a local authority, such as a County Council, desires to spend money upon some object which comes within the purview of the Home Office, the sanction of the Home Secretary must be obtained.

A veto will be exercised in a proper case. It appears that the Essex County Council, being minded to build a new county lunatic asylum at Colchester, delegated to their Committee of Visitors the duty of obtaining tenders. Messrs. Waring & White's tender, which amounted to £193,139, was accepted, although it was not the lowest. The committee had, however, made it clear that they did not bind themselves to accept the lowest or any tender. Mr. Gladstone refused to sanction the contract on the grounds (1) That the tender was not the lowest; (2) That other firms were not offered the same opportunity of reconsidering their tender as was afforded to Messrs. Waring & White; and (3) That the acceptance of this firm's tender involved a system of sub-contracting which, in Mr. Gladstone's opinion, was in itself a serious objection. In spite of the fact that the committee stated that the successful firm were not, in fact, invited to reconsider their tender, the Home Secretary refused to reconsider his decision.

It would not, of course, be wise to lay down the general principle that local authorities shall always accept the lowest tender, but tenders are often accepted for indirect reasons. A particular contractor is chosen because he pays Trade Union wages, or because he belongs to a particular section. Again, the practice of accepting a higher tender on the mere ground that it gives employment to local men is one which may lend itself to every kind of abuse. In intervening to prevent the growth of any such abuse, the Secretaries of State would perform a useful service. It may be hoped that the fact that the Home Secretary has intervened—whether rightly or wrongly—may lead the President of the Local Government Board to intervene in suitable cases which come within his range.

NEW PATENTS APPLIED FOR, 1912.

(NOT YET PUBLISHED.)

ompiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford, to whom all inquiries should be addressed.

19,963. "Magneto-electric machines." O. Bartschi. September 2nd.

19,980. "Fuses for use in electrical circuits." Siemens Schuckertwerke G.m.b.H. (Convention date, September 2nd, 1911, Germany.) September 2nd. (Complete.)

20,076. "Electrical insulator and binder." A. Watkins. September 3rd.

20,101. "Chemical generators of electricity." O. Sozzi. September 3rd. (Complete.)

20,113. "Electric motor-starters, controllers and the like." F. J. Moffett and N. B. Rosher. September 4th. (Complete.)

20,116. "Means of grinding up motor and dynamo commutators." W. J. Davey. September 4th.

20,154. "Electric wiring systems." A. P. Lundberg, G. C. Lundberg and P. A. Lundberg. September 4th.

20,161. "Electric lighting device for railway carriages." C. Kolbe. September 4th.

20,180. "Electrolytic pickling of metals." P. Marino. September 4th. (Complete.)

20,185. "Driving self-propelled and electrically-driven agricultural machines." W. Wortmann. September 4th. (Complete.)

20,191. "Electrically-heated hot-air douches." A. Schaeffer. (Convention date, December 223rd, 1911, Germany.) September 4th. (Complete.)

20,196. "Telephonic transmitting appliance." J. K. Rhodes. (Convention date, April 6th, 1912, United States.) September 4th. (Complete.)

20,224. "Brush-holder." A. E. Berdon. September 5th. (Complete.)

20,225. "Direct-current generators." A. E. Berdon. September 5th. (Complete.)

20,244. "Motor-actuated extension ladders for fire-escapes and the like." "Cedes" Electric Traction, Ltd., and E. Clifford. September 5th. (Complete.)

20,247. "Electro-magnetically operated switches, particularly adapted for controlling electric motors." E. Schattner. September 5th. (Complete.)

20,248. "Spark plugs." J. J. Thompson. September 5th. (Complete.)

20,252. "Electric resistance grids." Electric and Ordnance Accessories Co., Ltd., G. Ralph and W. G. H. Cox. September 5th.

20,269. "Electrically-operated suction cleaners for the extraction of dust and the like." Armorduct Manufacturing Co., Ltd., W. C. Jeary and J. P. Arnacker. September 5th. (Complete.)

26,270. "Electrical switch." J. G. Doran. September 5th.

20,285. "Means for receiving wireless telegraph signals." Marconi's Wireless Telegraph Co., Ltd., and C. S. Franklin. September 5th.

20,290. "Ignition plug having stationary electrodes for explosion motors." K. Lindenmann. September 5th. (Complete.)

20,293. "Memorandum and like appliances for use in connection with telephones and other purposes." E. F. M. Bransom and F. H. Bowden, trading as Branson & Bowden. September 6th.

20,295. "Wall and like plugs." W. W. Timewell and S. Sheen. September 6th.

20,345. "Telephone meters." G. L. Bates. September 6th.

20,357. "Electrical connections." W. E. Lake. (Soc. Anon. Le Carbone, France.) September 6th.

20,361. "Incandescent electric lamps." C. Joly. September 6th.

20,366. "Electrically self-winding clocks." F. H. Walker. September 6th. (Complete.)

20,401. "Engine tell-tale or alarm mechanism for use in connection with engine-room telegraphs." H. Smith. (John Dawson Smith, High Seas.) September 7th.

20,442. "Photo-telegraphy." T. T. Baker. September 7th.

20,446. "Safety arrangements for overhead electric railway or tramway systems." J. E. Pollak. (Elektromotoren-Werke Hermann Gradenwitz, Germany.) September 7th. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of the Specifications in the following list may be obtained of Messrs. W. P. Thompson & Co., 285, High Holborn, W.C., and at Liverpool and Bradford; price, post free, 9d. (in stamps).

1911

Electrical Conduit Junction Boxes. T. G. Gatis. 15,866. July 8th.

Envelopes or Supports for the Resistances in Electric Heating Apparatus. C. O. Bastian. 16,143. July 12th.

Machine for Winding Wire or the like upon Hose Pipes, Insulation upon Cables, and for Analogous Purposes. W. Furstenberg. 17,998. August 8th.

Application of Electric Currents for Preventing the Corrosion of the Tubes of Surface Condensers. A. Harris. 18,220. August 11th.

Electrical Heating Element. T. Judd. 18,334. August 14th.

Manufacture of Metal Filaments for Electric Lamps. F. R. Grote. 18,351. (Cognate application, 27,290 of 1911.) August 14th.

Manufacture of Filaments for Incandescent Electric Lamps. H. Hoge and "Z" Electric Lamp Manufacturing Co. 18,892. August 14th.

Sparking Plugs of Internal-combustion Engines. F. A. L. Johnson. 19,800. (Cognate application, 23,960 of 1911.) September 6th.

Electric Heating Apparatus. C. M. Holmquist. 21,026. September 23rd.

Electrically-heated Sad-irons. H. J. C. Forrester. (Diamond Electric Co.) 22,111. October 7th.

Fittings for Incandescent Electric Lamps. F. Gunn and W. T. Nicholson and Clipper Co. 26,377. November 23rd.

Electric Safety Lamp. H. Sefton-Jones. (Electric-Exporte Werke Ges.) 27,826. December 11th.

Switches for Mono-rail Telpher Tracks and the Like. R. Dempster and Sons, Ltd., and W. Mitton. 29,062. December 28rd.

Wiring of Contacts of Telephone Switches. Western Electric Co., Ltd. (Western Electric Co.) 16,868. July 22nd.

Protecting Coverings for Electric Conductors or Cables. W. C. Blackett and W. C. Mountain. 18,212. August 11th.

Telegraph Instruments. British Insulated and Helsby Cables, Ltd., and G. W. Moore. 19,065. August 25th.

Regulators for Electrically-driven Ring Spinning and Doubling Machines. Siemens Bros. Dynamo Works, Crowley and S. Gowan. 19,084. (Addition to 23,641 of 1910.) August 25th.

Regulators for Electrically-driven Ring Spinning and Doubling Machines. Siemens Bros. Dynamo Works, Crowley and S. Gowan. 19,085. August 25th.

Electric Battery Lamp. Van Raden & Co. and M. Metz. 19,194. August 28th.

1912.

Mechanical Connectors for Electric Cables. F. Neave and Callender's Cable and Construction Co. 163. January 2nd.

Method for Applying an Electrically-conductive Layer upon an Electrically Non-conductive Surface. H. E. Goldberg. 3,644. February 13th.

Manually or otherwise Operated Electric Switches with Automatic Releasing Mechanism. E. T. R. Murray. 6,112. March 11th.

Electric Motor for Transmitting Angular Movements with an Auxiliary Motor which Controls the Successive Displacements for it. R. Girardelli. 6,496. March 15th. (March 15th, 1911.)

Alternating-current Electricity Meters. Siemens-Schuckertwerke Ges. 6,647. March 18th. (March 18th, 1911.)

Method of Restraining the Augmentation of an Electric Current and Contrivance therefor. A. N. Hazlehurst and Longstreth's, Ltd. 6,882. March 20th.

Electricity Meters. Isaria Zahlerwerke Akt.-Ges. 8,075. April 3rd. (April 3rd. 1911.)

Ferro-concrete Pole, especially for Supporting Electric Conductors. P. Rose and A. Oldenburg. 8,088. April 3rd.

Oil-brake Electric Switches. R. H. Barbour and T. G. Travis. 10,528. May 3rd.

Electric Switches. H. G. C. Fsirweather. (Hart Manufacturing Co.) 10,704. May 6th.

Clutch Gear for Hughes Telegraph Apparatus. Siemens Bros. & Co. (Siemens & Halske Akt.-Ges.) 12,318. May 24th.

Electric Switches. Siemens Brcs. Dynamo Works, Ltd. (Siemens Schuckertwerke Ges.) 12,980. June 3rd.

Power from Rills.—It is surprising how much there is to be learnt by the engineer when on a holiday, by simply keeping his eyes open. A correspondent recently paid a visit to Huelgoat, a pleasure resort in the heart of Brittany, about 40 miles to the east of Brest. Describing it, *à la* guide book, he says "it is picturesquely situated in the midst of a dense forest of pines, which at one time covered a vast tract of country. The wild boar still roams at large in what is left of the forest." To chase this beast is forbidden; a very unnecessary monition, because owing to his innate ferocity the *sanglier* generally does the hunting himself. In a lovely valley some way below the town, a power station is to be found; but the casual visitor looks in vain for the lake or reservoir from which the water supply is drawn. The secret is discovered if he makes his way through the pines, bracken, and osmunda fern which clothe the mountain sides. At an elevation of about 600 ft. he will discover a canal about 5 ft. wide, and not more than 2 ft. deep, which runs right round the valley for a distance of about 4 miles. It is fed by a myriad of rivulets which find their way into it from beneath the undergrowth. The intake is placed above the generating station. Owing to the fact that streams are more constant in a wooded country, the supply appears to be perennial, and enough power is generated for the purposes of a silver and lead mine which is worked in the valley. Here, then, in an out-of-the-way part of Brittany, one finds the forces of nature pressed into the service of man in a manner which combines efficiency with economy; but, as if to show that the Breton has not wholly accepted the teachings of modern science, you pass into the next valley to find a threshing machine worked by eight horses; the animals are urged to further exertion by a man who sits on a revolving pedestal in the centre.